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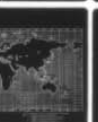
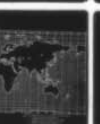
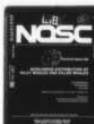
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WORLDWIDE DISTRIBUTION OF PILOT WHALES AND KILLER WHALES.(U)
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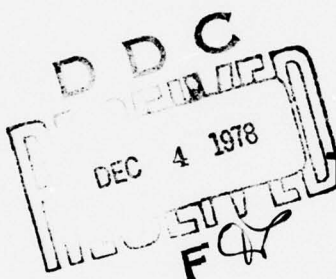
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Technical Report 295

WORLDWIDE DISTRIBUTION OF PILOT WHALES AND KILLER WHALES

JS Leatherwood
ME Dahlheim
1 June 1978

Research and Development: 1 Oct 1976 - 30 Sep 1977

Prepared for
Naval Electronic Systems Command
and Naval Sea Systems Command

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2) Two world maps, one bearing a summary statement about distribution in each area for which information is available, and the other bearing numerical values indicating the likelihood of occurrence in each 5-degree sector of ocean throughout the world, and

3) A bibliography of the sources used to compile the distribution data.

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SUMMARY

OBJECTIVE

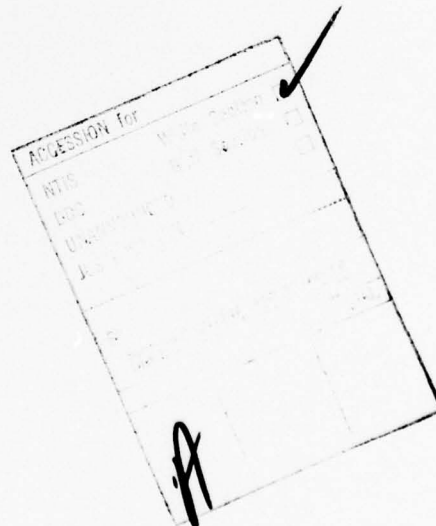
The objective of this work was to summarize what is known and can reasonably be predicted about the distribution and seasonal movements of the pilot whale and the killer whale. The results are to be incorporated with other materials into a handbook designed to assist the Navy sonar operator in identifying the natural sounds he encounters in the oceans of the world.

RESULTS

A summary was made, based on published records of what is known about the seasonal worldwide distribution of pilot whales and killer whales, and an extensive bibliography was prepared. Using these data, an attempt was made to predict, by location, and by season, the probability of encountering pilot whales and killer whales.

RECOMMENDATIONS

Similar comprehensive studies of zoogeographic distribution should be completed for other vociferous marine mammals. Zoogeographic information derived from unclassified sources should be correlated with similar information obtained from Fleet sonar operators in order to present a balanced prediction of the species likely to be encountered in different Fleet operating areas.



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INTRODUCTION

This report summarizes what is known and can reasonably be predicted about the distribution and seasonal movements of two small toothed whales: the pilot whale (*Globicephala* spp.) and the killer whale (*Orcinus orca*). The report has been prepared from the abundant but scattered literature on these whales, supplemented by previously unpublished data, primarily for the eastern North Pacific, collected by the Naval Ocean Systems Center. Subsequently, the results presented will be incorporated with other materials in a handbook designed to assist the Navy sonar operator in identifying the natural sounds he encounters in the oceans of the world.

Any report on the distribution and movements of all except the best known species of whales, such as the California gray whale (*Eschrichtius robustus*), should be prefaced by a few general remarks. In 1874 the famous whaling captain and naturalist, Charles Scammon, summed up the field of cetacean research as follows:

It is hardly necessary to say that any person taking up the study of marine mammals, and especially the cetaceans, enters a difficult field of research, since the opportunities for observing the habits of these animals under favorable conditions are rare and brief. My own experience has proved that close observation for months, and even years, may be required before a single new fact in regard to their habits can be obtained. This has been particularly the case with the dolphins, while many of the characteristic actions of whales are so secretly performed that years of ordinary observation may be insufficient for their discovery.

This pessimistic appraisal remains true even today. Cetaceans continue to be difficult to study. They range far in the world's oceans, often appearing only in remote areas where cost and logistics limit the opportunities for study. Even when they appear close to populated coasts, where field studies are more feasible, they are sometimes difficult to identify and always slow to yield their secrets. As mammals fully adapted to an aquatic environment, they conduct the majority of their activities under the water and out of view. They are generally observable by biologists only during the brief periods when they come to the surface to breathe. A typical encounter is an ephemeral swirl of jumbled activity that provides a slim basis on which to interpret their behavior.

The best known species of cetaceans are those exploited by the whaling industry and those that inadvertently become entangled in the nets of commercial fishermen. Even for most of these species, however, the only information that has been systematically collected and analyzed is that regarding their abundance in accessible areas. Information on other subjects of interest, such as their seasonal movements between whaling or fishing grounds, is less plentiful and less detailed. For the many species of cetaceans that are not of commercial value and do not associate with commercially exploited fishes, we often know little except what can be observed or deduced from carcasses thrown up with other ocean litter on the beaches of the world.

Under such circumstances it is not surprising that for most areas of the world we were unable to produce tidy charts predicting the probability of encountering pilot whales and killer whales by season. The best we could do was to summarize what is known about their distribution, on the basis of the published record, and attempt to predict the likelihood of encountering them elsewhere. The predictions given are based on the published evidence regarding the preferred habitats of these cetaceans and on certain general considerations regarding the distribution of life in the ocean.

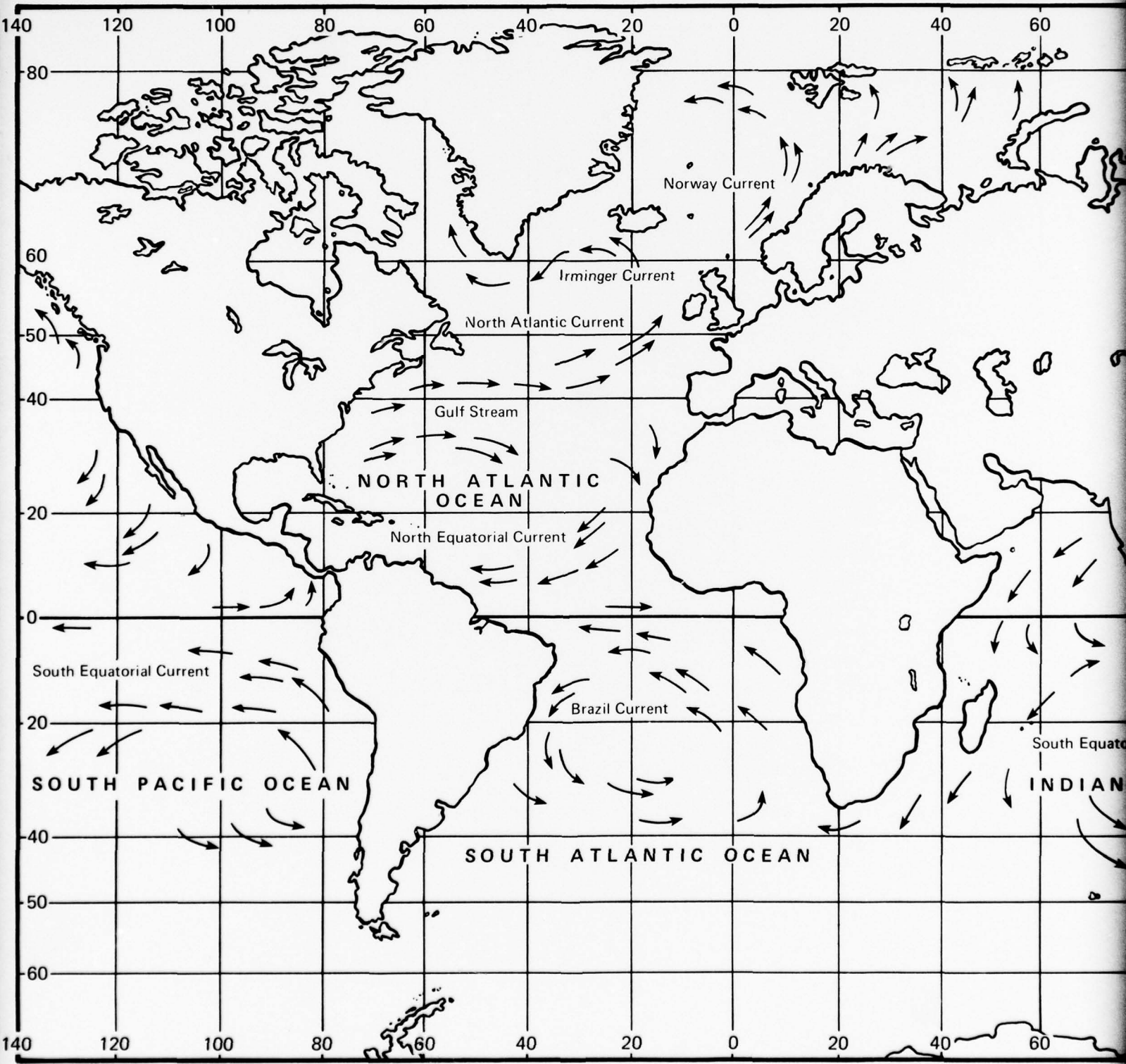
In the latter respect it should be kept in mind that the oceans of the world are not uniform. Their bottom, like the surface of continents and islands, constitutes a diverse terrain characterized by coastal shelves that fall off to deep abysses containing fissures, trenches, sandy plains, volcanic mountains reaching near or above the surface, and mountain chains of great height and magnitude. Above these is the fluid mass of water, which supports life, as the atmosphere does above the land. The water moves and is mixed by broad circling currents created by winds and the earth's motion.

Most currents are rich in nutrients and support abundant life, particularly where they flow over bottom structures, such as sea mounts, that cause them to well up toward the surface. Nutrient-rich waters are also found in the major coastal deltas, which benefit from the outfall of rivers, and in polar regions, where long summer days foster the growth of plants that are the basis of the food chain. In the polar areas, however, the availability of nutrients and accessibility of food rich areas to air breathing mammals are influenced by the extent of the seasonal ice pack. Figure 1 is a map of the world showing the major ocean currents. Figures 2 and 3 show the extent of the Arctic and Antarctic ice packs.

Always near the top of the food chain wherever they occur, cetaceans are generally found in nutrient-rich areas. In fact, finding other life in abundance generally means that cetaceans will not be far away. Knowing this, a mariner can begin on his own to predict their occurrence in areas he frequents. It should be noted also that most sea life is noisy, contributing as either active source or passive scatterer of sound, and that in a general way abundance can be equated with levels of natural noise.

With the above considerations in mind, then, let us examine the two whales of interest. For both whales the following kinds of information are given:

1. a written summary describing distribution by major oceanographic area; these summaries include detailed information, derived from the best published reports, on local distribution and seasonal abundance.
2. two world maps, one bearing a summary statement about distribution in each area for which information is available, and the other bearing numerical values indicating the likelihood of occurrence in each 5-degree sector of ocean through the world.
3. a bibliography of the sources used to compile the distribution data.



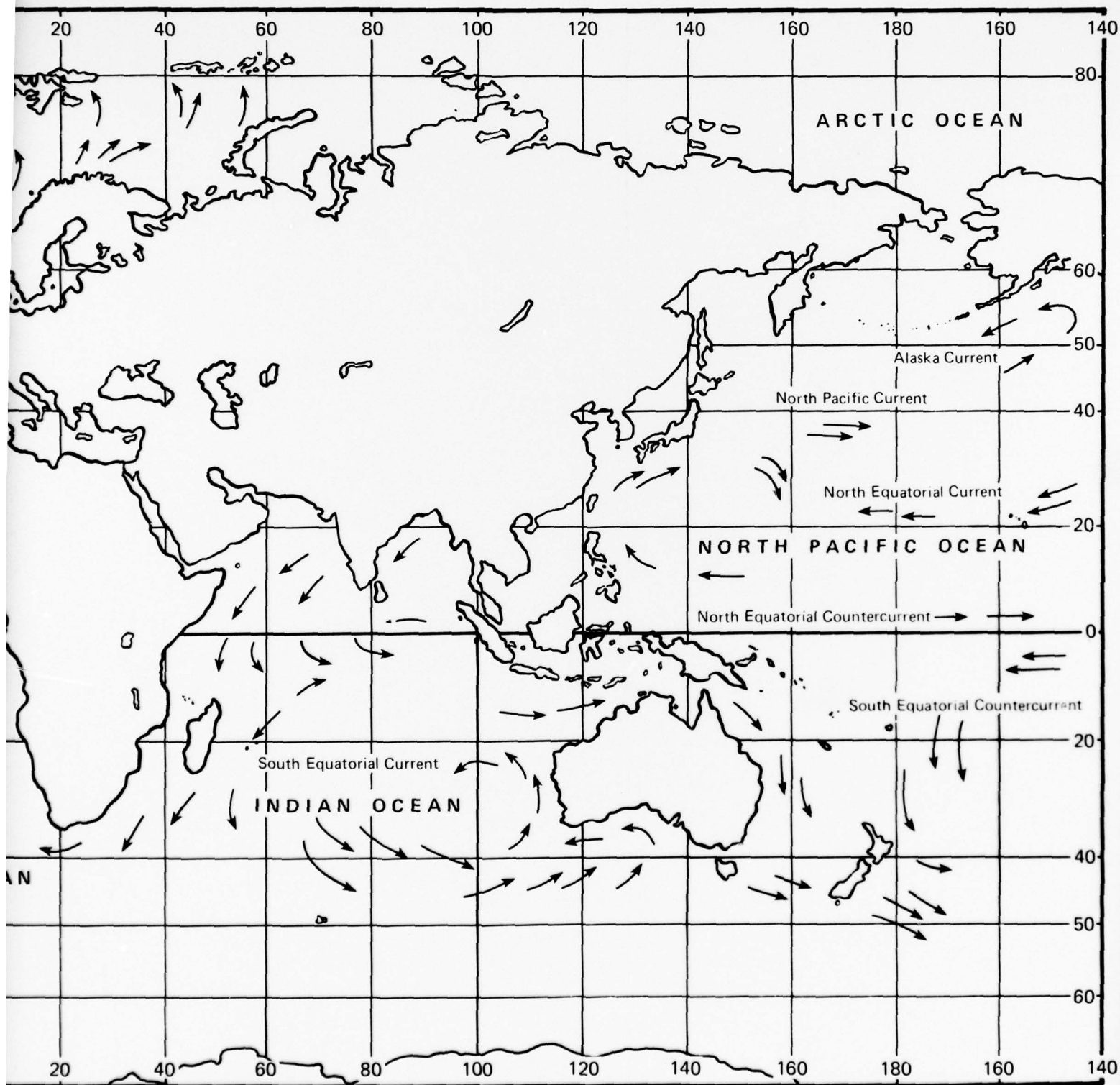


Figure 1. Currents of the world's oceans.

SOUTHWARD EXTENSIONS OF ARCTIC ICE MASSES

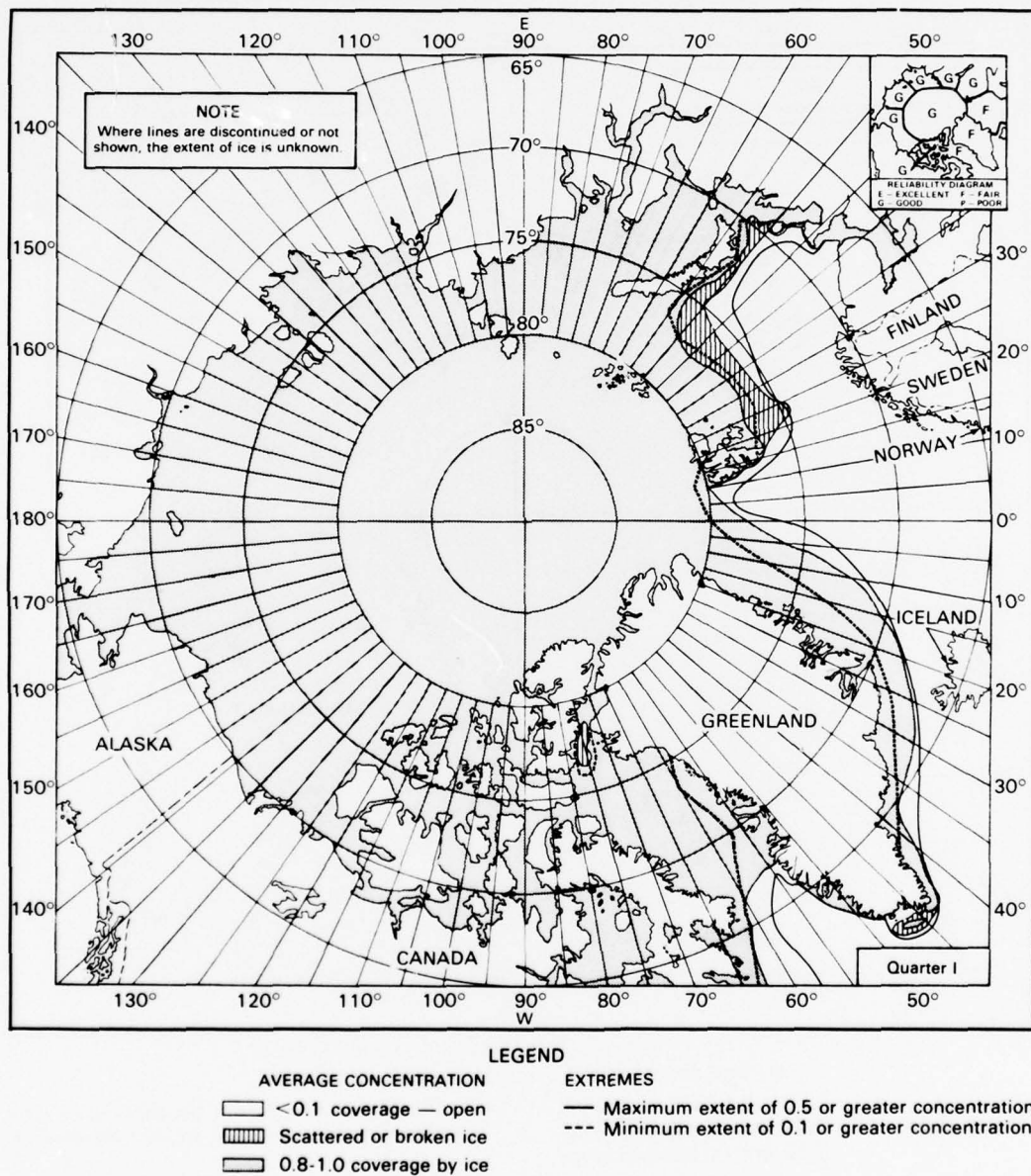


Figure 2. Arctic ice pack. (a) Quarter 1.

SOUTHWARD EXTENSIONS OF ARCTIC ICE MASSES

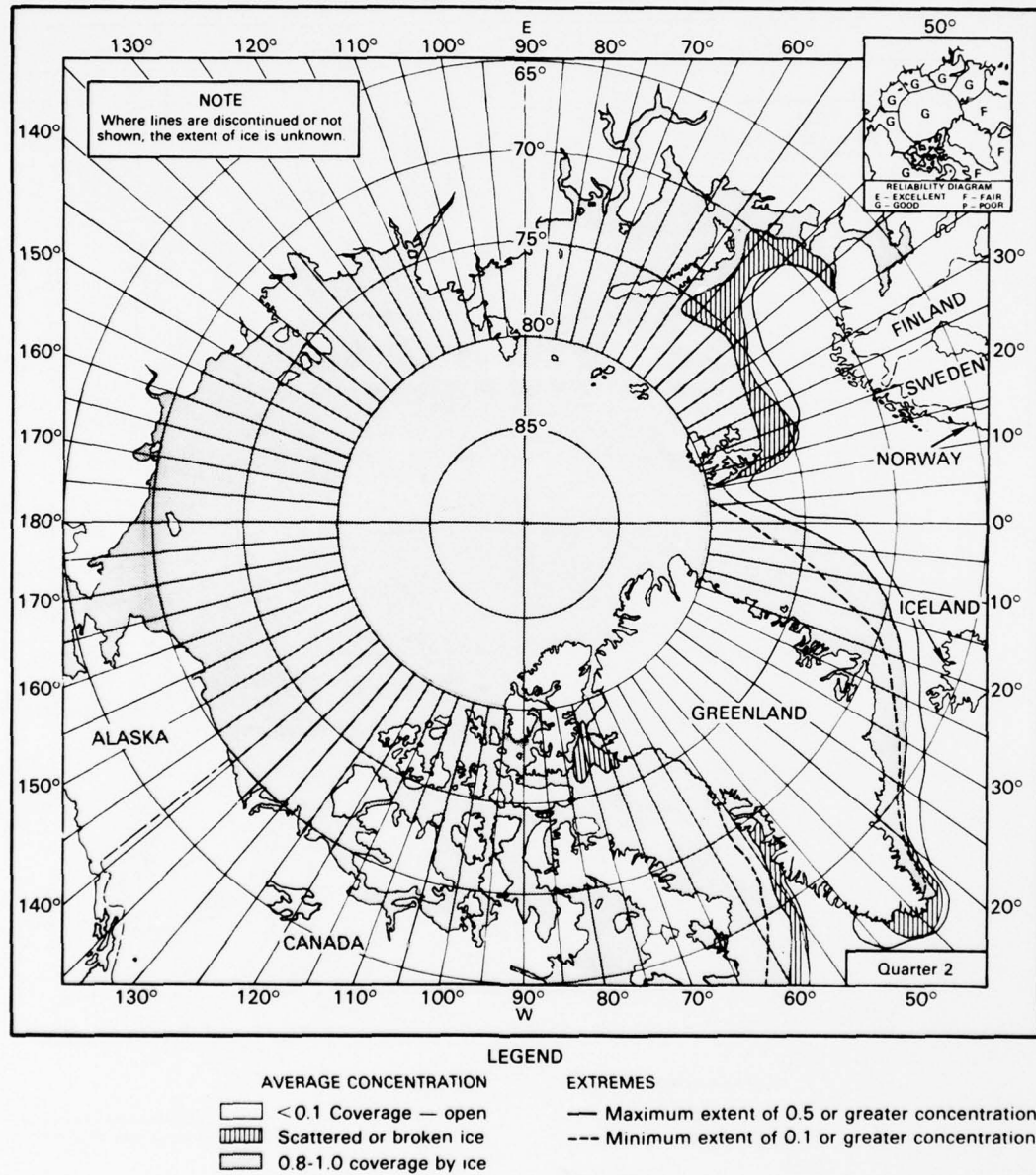


Figure 2. Continued. (b) Quarter 2.

SOUTHWARD EXTENSIONS OF ARCTIC ICE MASSES

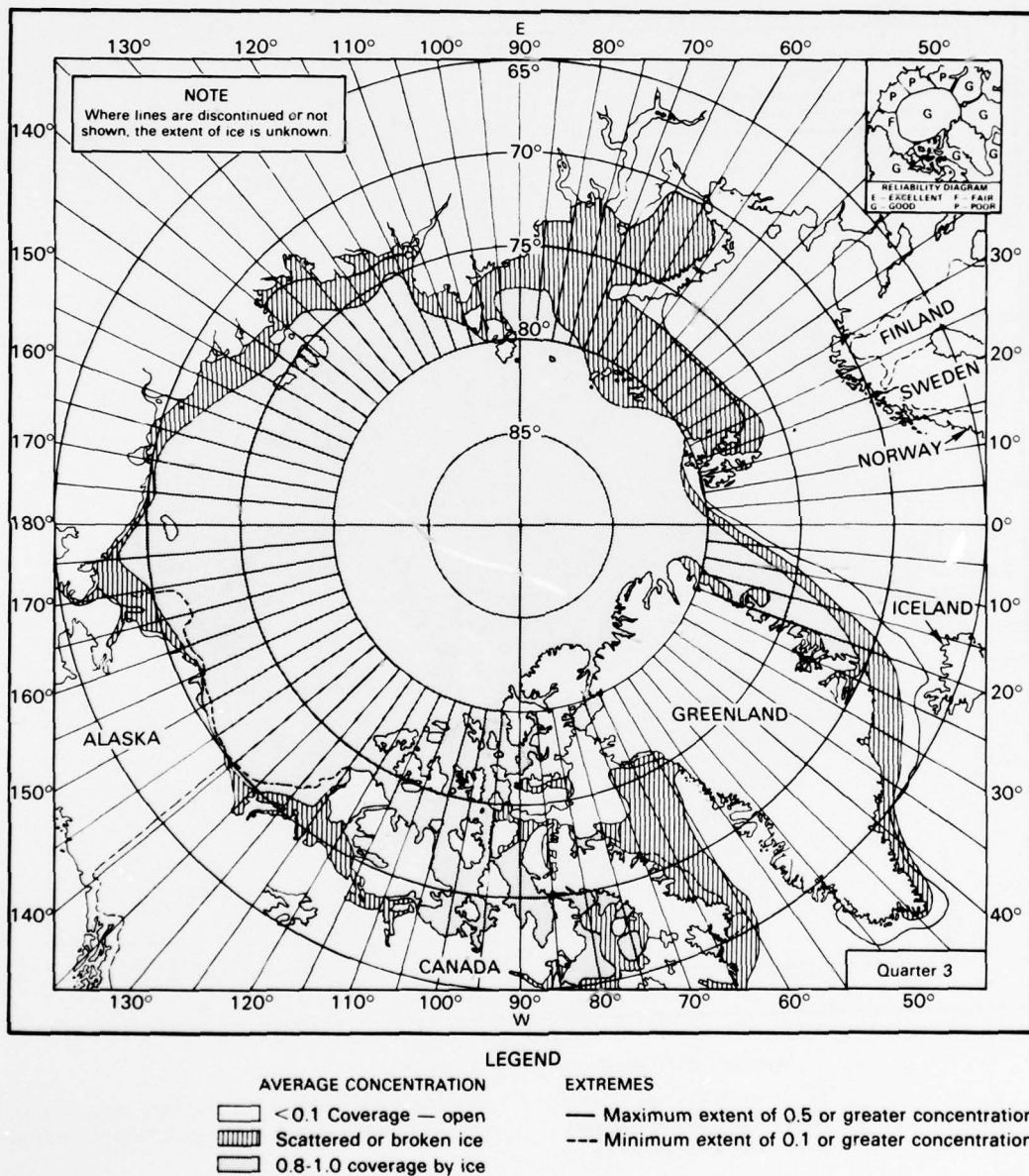


Figure 2. Continued. (c) Quarter 3.

SOUTHWARD EXTENSIONS OF ARCTIC ICE MASSES

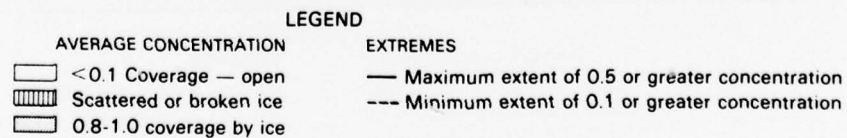
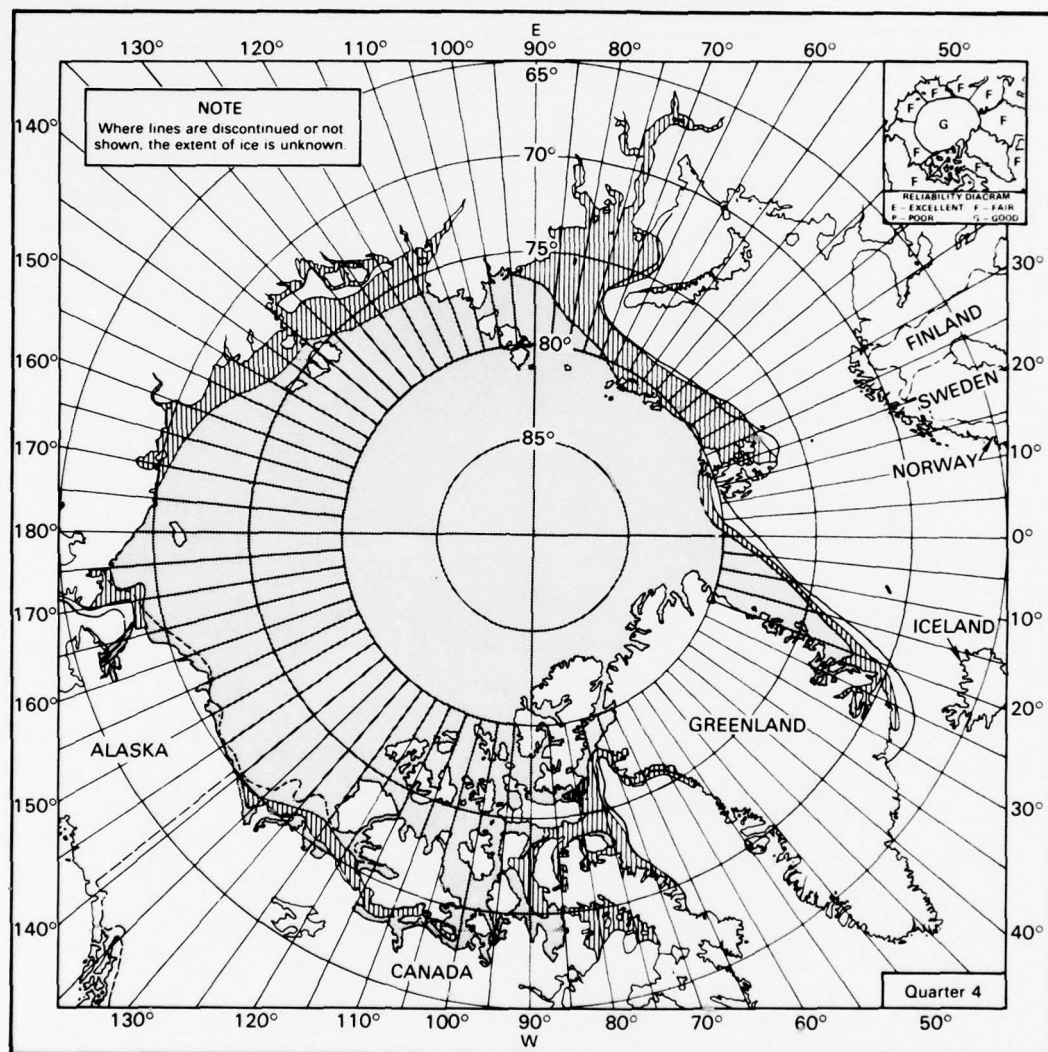


Figure 2. Continued. (d) Quarter 4.

ACCESSIBILITY OF ANTARCTIC COASTS

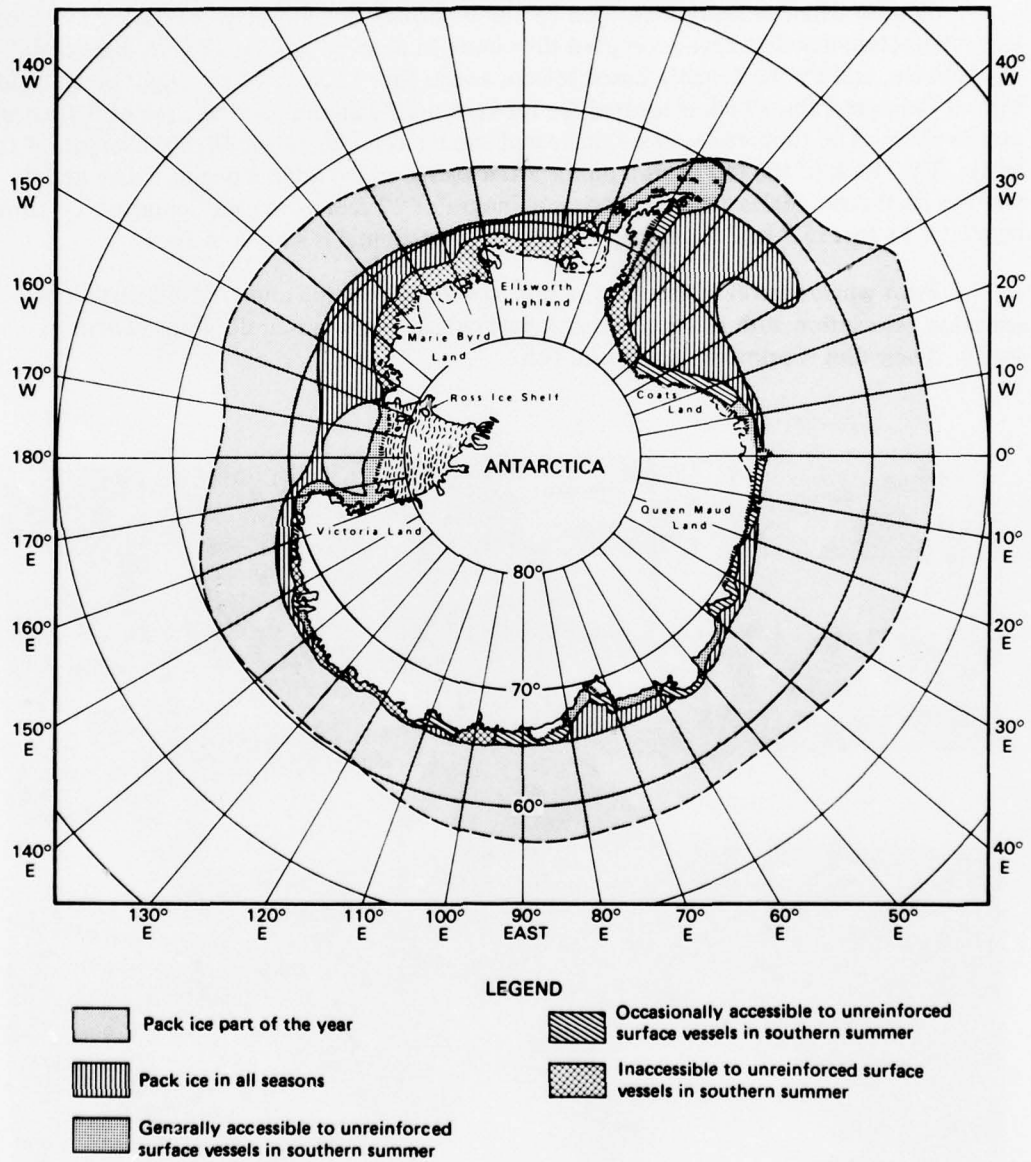


Figure 3. Antarctic ice pack.

PILOT WHALE

DESCRIPTION

A pilot whale is easily identified by the bulbous head and black or dark gray coloration, characteristics that have prompted the common names "pot head" and "blackfish," respectively, and by the broadly based falcate dorsal fin. There is often a light gray "saddle" behind the dorsal fin, which is located far forward on the animal, and an area of lighter gray on the chest. The flippers are also falcate and can be as much as one-fifth the length of the body. The stock of the tail bears a hump often visible as the animal begins a dive and exposes its flukes. Males attain a maximum length of 22 feet (7 m) and females a maximum length of 18 feet (5.7 m). A photograph of a typical animal is shown in fig 4.

Pilot whales travel in groups of a few to several hundred and are frequently observed in association with other cetaceans, particularly bottlenosed dolphins (*Tursiops* spp.). Their diet is primarily squid and fish.

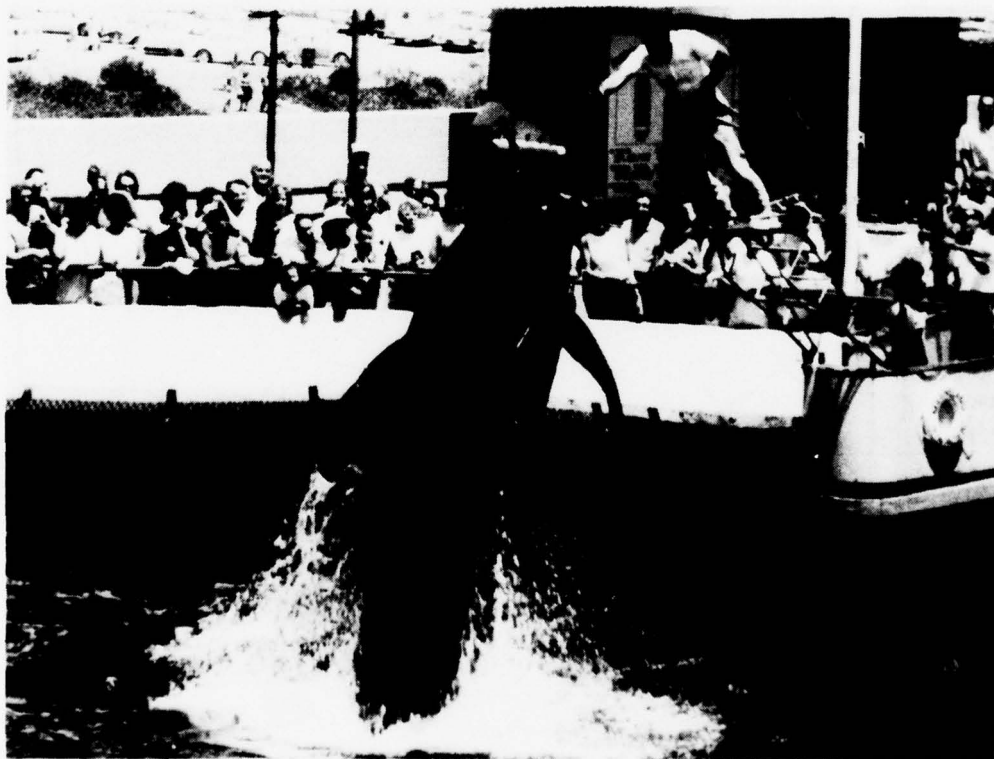


Figure 4. Pilot whale.

DISTRIBUTION

Pilot whales occur in all oceans of the world except extreme polar waters. Their abundance is poorly known in most areas. They range from near the shore to mid-ocean.

Data on pilot whale distribution are difficult to obtain for several reasons:

1. pilot whales are not generally commercially valuable, and the few fisheries that exist are primitive and localized and do not furnish much data;
2. they are often pelagic, and data on their seasonal abundance in mid-ocean are difficult to obtain. Most distributional data are for regions near coasts and near population centers.

The polar limits of pilot whale distribution are fairly well known and are about 60°N latitude in the North Pacific, about 70°N latitude in the North Atlantic, and about 60°S latitude in the Antarctic. Distribution between these limits is more or less continuous in areas of high productivity, with increasing abundance as one moves from polar through temperate to tropical waters.

Pilot whales often strand themselves, and in many areas stranded animals furnish the only documentation of their occurrence. While stranding data give useful information on distribution, they should not be used to determine seasonal abundance and migration habits because factors other than abundance, such as weather and parasite infestation, may affect the probability of strandings. Similarly, catch data on pilot whales should be used with caution because they may not give a true estimate of abundance.

There are a few areas where seasonal abundance is well known: Southern California (28),* Newfoundland (48, 50), and Japan (24, 40). It is generally agreed that pilot whale populations migrate, but few migrations have been thoroughly studied. The preferred food of the pilot whale is squid, and abundance of pilot whales in several areas has been correlated with abundance of these cephalopods (28, 34). Migrations may also occur as a result of breeding and calving (16, 39, 54). Whatever the cause of migration, average herd size tends to increase during these times. The most general type of migration is related to water temperature, a shift toward the poles in summer and toward the equator in winter.

The following paragraphs describe the distribution of pilot whales in the major ocean regions of the world. As noted above, the information presented is derived primarily from the published record. Figure 5 is a map of the world providing a summary of this information, and figure 6 is a similar map indicating the probability of encountering pilot whales throughout the world.

North Atlantic

More data are available on pilot whale distribution in the temperate and arctic regions of the North Atlantic than in any other ocean region. Most of the long-lived fisheries for pilot whales have been concentrated in this region (36).

Pilot whales probably range farther north in the eastern Atlantic off the coast of Norway, because of the warmer currents, than in the western Atlantic off the coasts of Canada and Greenland. On both sides of the Atlantic, however, they occur north of roughly 55°N latitude almost exclusively in summer (3).

* Numbers in parentheses identify publications, listed alphabetically by author's name, in the bibliography on pilot whales at the end of this section.

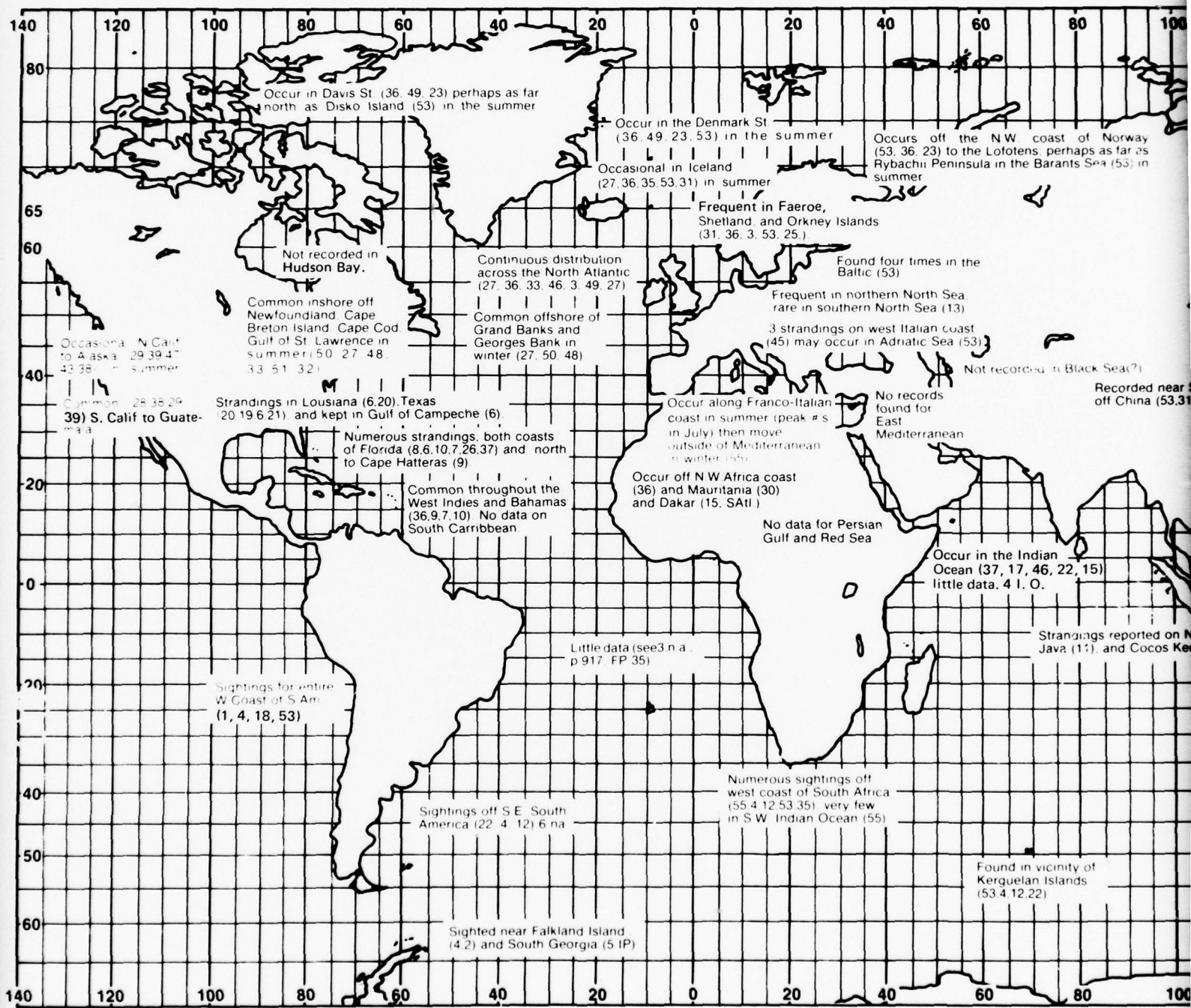


Figure 5. Summary of published i

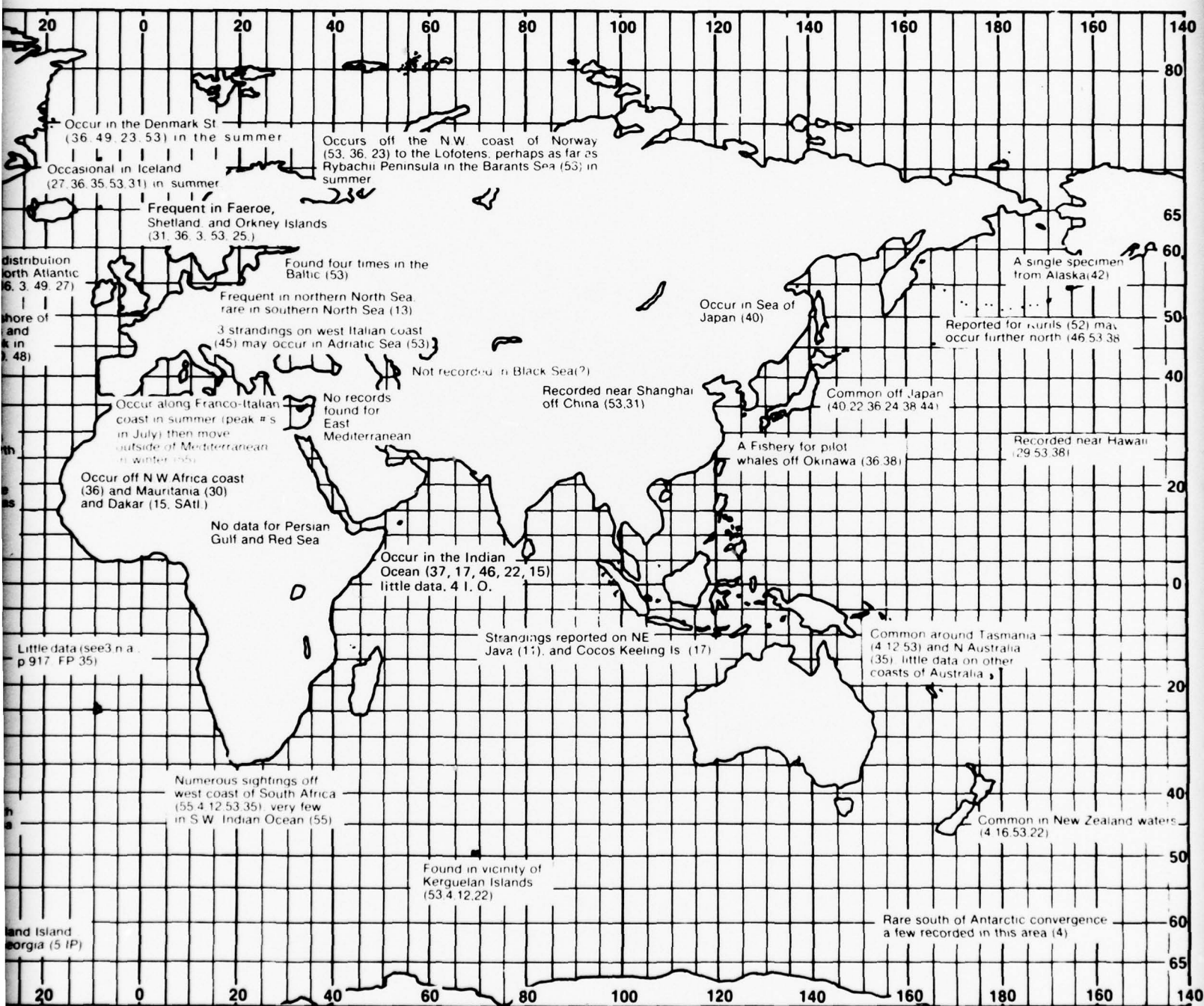


Figure 5. Summary of published information on the worldwide distribution of the pilot whale.

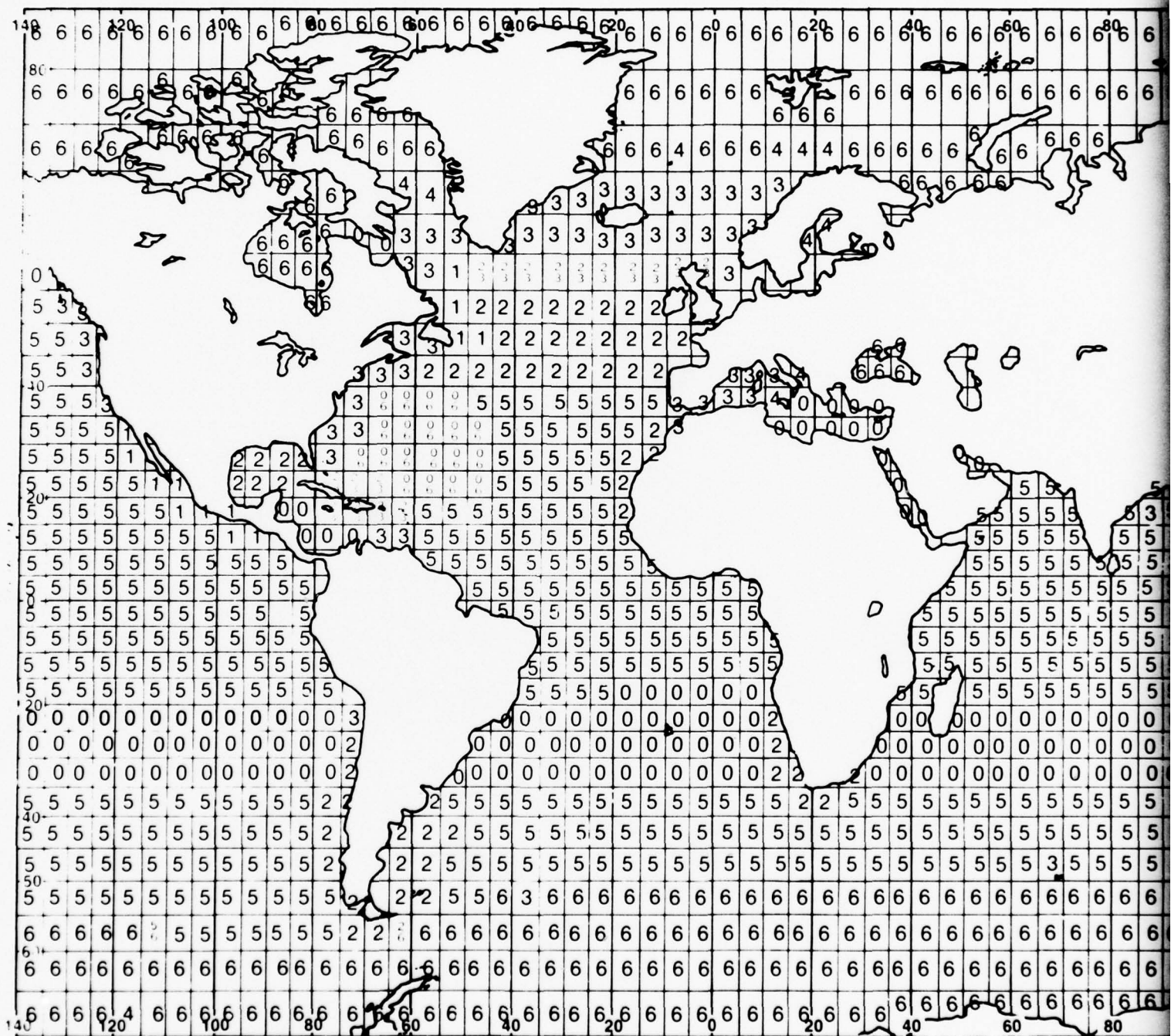


Figure 6. Likelihood
 Key: 0 = no p
 1 = publ
 2 = publ
 3 = publ
 4 = pres
 5 = pres
 6 = pres

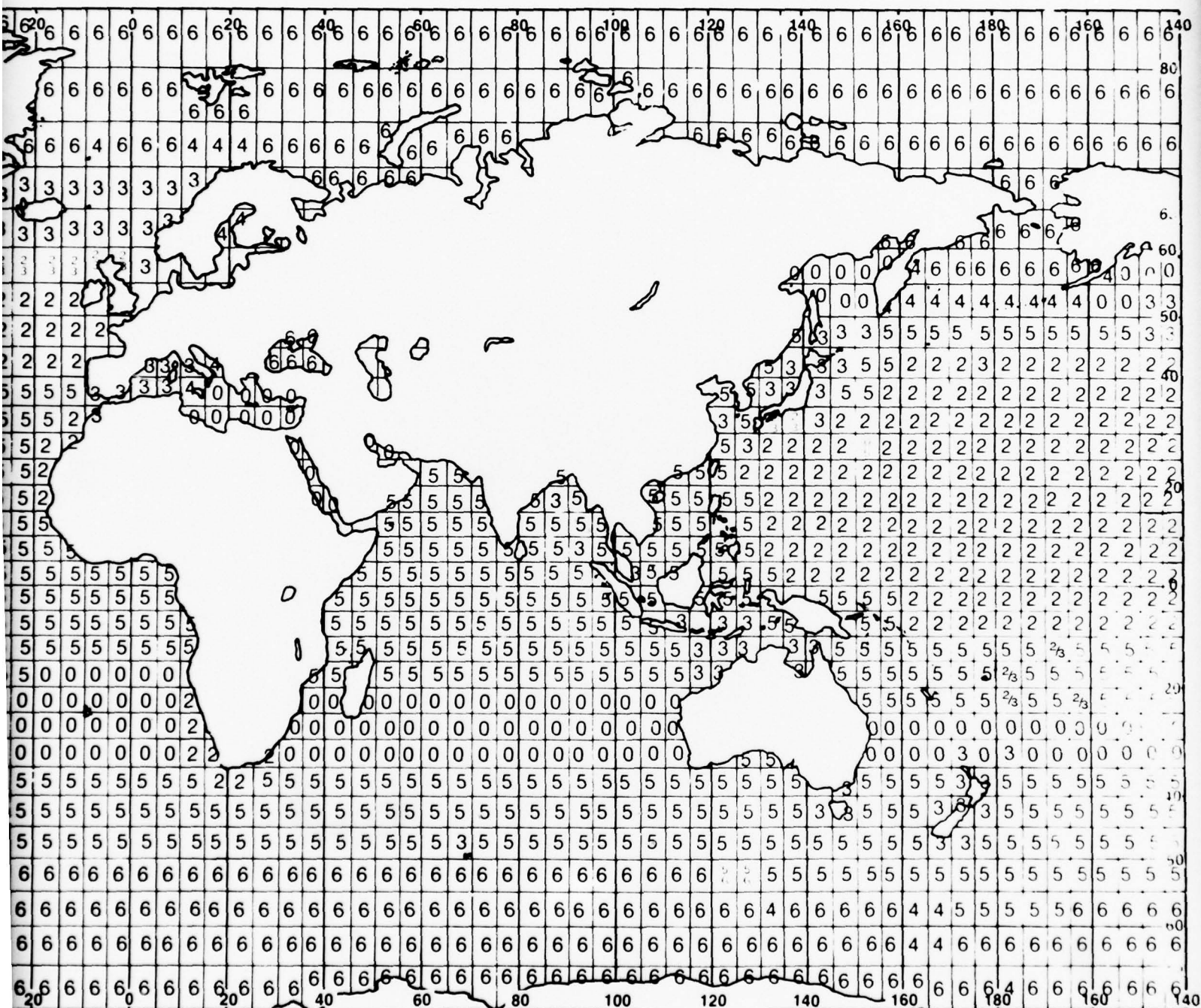


Figure 6. Likelihood of occurrence of the pilot whale in the world's oceans.

- Key:
- 0 = no published information, status unknown;
 - 1 = published record indicates abundance the year around;
 - 2 = published record indicates presence the year around;
 - 3 = published record indicates seasonal presence;
 - 4 = presence reported but natural occurrence questionable;
 - 5 = presence not reported but predicted;
 - 6 = presence not reported and not predicted.

In the Davis Strait off western Greenland, pilot whales have been recorded as far north as 64°N (49); they may occur as far north as Disko Island (53). We found no records for Hudson Strait or Hudson Bay. Pilot whales occur in the Denmark Strait in fair numbers; large schools were reported in the northeast part at about 65°N, 30°W (23, 49). Occurrence in near-shore Iceland is apparently rather incidental (36). A small fishery for pilot whales is located in Norway, in the Lofoteus (36). There is a questionable report of pilot whales at Rybachii Peninsula in the Barents Sea (53); they may occur occasionally in the Baltic (53).

Occurrence of pilot whales near Newfoundland is fairly well documented. They arrive in coastal waters from Cape Breton Island north to Southern Labrador and in the Gulf of Saint Lawrence in early summer (50); their movement inshore is apparently correlated with movements of squid (34). In the Gulf of Maine they occur inshore, but this is not common (48, 50, 33). They are most regularly found in the deeper bays of Newfoundland. They also occur in deeper waters off Cape Cod and in the central Labrador Sea in summer. These inshore movements last from about July to late October. All year round, but particularly in winter, they occur outside the continental shelf east of the Grand Banks and near the Flemish Cap, and in the North Atlantic current waters (48, 50). They occur as far north as 55°N in winter months, and their distribution is continuous (49).

A fishery for pilot whales has existed in the Faeroe Islands at least since 1584 (35); pilot whales are most numerous there in July and August (25). They also occur in the Shetland and Orkney Islands, and many strandings have been reported for all seasons along the coasts of the United Kingdom (41). In the North Sea, they are more common in the northern part than the southern (13).

We have no data for the Sargasso Sea area, and assume that pilot whales do not occur there.

Mediterranean

In the Mediterranean, pilot whales occur near the French-Italian coast northwest of Corsica starting in May; the greatest numbers occur in July, with continued high numbers through September. In December they are gone, having moved out into the Atlantic (54). A few strandings have been recorded on the west coast of Italy (45). Pilot whales may also occur in the Adriatic Sea (53), but we have no data for the eastern Mediterranean and Black Sea.

Central Atlantic

Pilot whales occur throughout the West Indies and Bahamas, in the Gulf of Mexico and Caribbean Sea, and north to Cape Hatteras. Caldwell (7) reports a tendency for the population to shift to the south in late winter and spring in the West Indies. Data for the north coast of South America are lacking, but there are no obvious oceanographic barriers to their presence in this region. Strandings have been numerous on both coasts of Florida (8, 26, 37); strandings have also occurred in Louisiana and Texas (19, 20). They are reported for the Gulf of Campeche off southern Mexico. It is likely that they are present throughout the year in the Gulf of Mexico (6).

Pilot whales are also common off northwest Africa (3, 15, 30); historically, large numbers were taken there by sperm whalers (36).

North Pacific

The northernmost record of a pilot whale in the Pacific is from Kanatak on the Alaskan Peninsula; it had been shot near shore (42). There are a few sightings off British Columbia (44), strandings in Washington and northern California (47), and occasional sightings off the coast of central California (39). In the eastern North Pacific, however, pilot whales are most numerous from Point Conception in California to Guatemala and in the open ocean to the south and west of Central America (28, 29).

In the western North Pacific, pilot whales occur as far north as the Kuril Islands (52). There are questionable reports for eastern Kamchatka, La Perouse Strait, the Aleutian Islands, and the Commander Islands (53). They are numerous in the seas surrounding Japan (discussed in more detail below). They occur near Shanghai and near the mouth of the Yangtze (53). There is a near-shore fishery for pilot whales in Okinawa in the spring (35, 38). We have no data for the South China Sea, but it is reasonable to predict their occurrence there.

The subject of pilot whale distribution and abundance has received detailed study in two areas of the North Pacific: Japan and Southern California.

In Japan there is an intensive and year-round fishery for whales and porpoises. Kasuya (24) states that pilot whales are distributed on the entire Pacific coast of Japan, and tend to be distributed offshore (50–100 miles). In southwest waters, the density of pilot whales is low, but slightly increases in autumn to spring; this condition is reversed in northeast waters, where density increases in the summer months. Ohsumi (40) provides data for the Sea of Japan, where pilot whales are taken, although the fishery is very small. The areas where the greatest numbers are taken extend offshore from Japan between 134°E and 138°E and between 35°N and 42°N. The peak catch for the latter area is August through October, and for the former April through June. Pilot whales are taken in all months of the year.

Off Southern California, pilot whales are most common in the winter months, October through March, corresponding with the inshore spawning migration of the squid. The timing varies from year to year, but the season usually begins in December and continues through February. Large aggregations of pilot whales may be found in the vicinity of La Jolla Submarine Canyon, the Isthmus, Catalina Harbor, Ben Wesson Point and Silver Canyon, surrounding Catalina Island, offshore from Point Vicente of Islas Coronadas, near the southern tip of San Clemente Island, and surrounding Sixty-Mile Bank and along the south shore of Santa Cruz and Anacapa Islands. Though pilot whales have been observed north of Point Conception, and well offshore from the California Channel Islands during the spring, summer and fall months, in the temperate mid-Pacific in winter, and near the South Central Pacific Islands in spring, it is not known where the great majority of the population found near Southern California locations during the winter months spends the rest of the year.

Central Pacific

Mid-ocean data on pilot whales are more scarce for the Pacific than for the Atlantic. Pilot whales occur year round in Hawaii, however, and throughout the tropical Pacific, at least in the winter.

A large data base has been accumulated for the eastern tropical Pacific (an area roughly bounded by 20°N, 20°S, and 140°W) by National Marine Fisheries Service observers assigned to tuna boats operating in this area. This is perhaps the most thorough body of data on cetacean distribution and abundance for any open-ocean area; unfortunately, the data on pilot whales were not compiled in time to be included in this report.

South Atlantic

Distribution data are very scarce for the South Atlantic. The more temperate species, *Globicephala melaena*, occurs in the cold current off the southeast coast of South America (12, 22, 35); there are a number of sightings in this area (4). This species is also numerous off the southwest coast of South Africa in the cold Benguela current and off the Cape of Good Hope (55). It has been sighted off the Falkland Islands and South Georgia Island (2, 4). We have no sighting data on the more tropical species, *G. macrorhynchus*, in the South Atlantic; it is thought to occur to 15°S on the African coast, and slightly farther south off South America (35).

South Pacific

The more temperate *G. melaena* occurs off the western South American coast in the Humbolt current (1, 35). Off Ecuador and Peru, the tropical species is common (1, 18). There are sightings in the vicinity of Samoa (Whale Watch Program), and the tropical species (*G. macrorhynchus*) is assumed to occur throughout the tropical South Pacific.

Off New Zealand, pilot whales are seasonally common in the summer months, probably coinciding with mating. South of New Zealand the most southerly observations of pilot whales have occurred (4); it is in this area that the Antarctic Convergence occurs farthest south. Pilot whales are common near Tasmania (4) and off the north coast of Australia (35); we have no data for the other coasts of Australia.

Indian Ocean

The fewest data are available for the Indian Ocean area. The temperate species has been sighted (4) and reported by many authors for the Kerguelen Islands. The tropical species occurs throughout the warmer Indian Ocean. This species is rare in the western Indian Ocean south of 22° (55). Strandings have occurred at the Ganges delta, the Straits of Malacca, the northern end of Sumatra, northeast Java, the Cocos-Keeling Islands, and Lombok or Solor in the Lesser Sunda Islands.

PILOT WHALE: BIBLIOGRAPHY

1. A. Aguayo. 1975. Progress report on small cetacean research in Chile. J. Fish. Res. Board Can., vol. 32 no. 7, pp. 1123-1143.
2. J. L. Bannister. 1968. Whales. Aust. Natur. Hist., vol. 16, no. 4, pp. 114-118.
3. S. G. Brown. 1961. Observations of pilot whales (*Globicephala*) in the North Atlantic Ocean. Norsk Hvalfangst-Tidende, vol. 50, no. 6, pp. 225-254.
4. S. G. Brown, R. T. Brownell, Jr., A. W. Erickson, R. J. Hoffman, G. A. Llano, and N. A. MacIntosh. 1974. Antarctic Mammals. Folio 18, Antarctic Map Folio Series, American Geographical Soc., pp. 13-19, plate 9.
5. R. L. Brownell Jr. 1964. Observations of Odontocetes in central California waters. Norsk Hvalfangst-Tidende, no. 3, pp. 60-66.
6. D. K. Caldwell, M. C. Caldwell. 1973. In A Summary of Knowledge of the Eastern Gulf of Mexico. The State University System of Florida, Inst. of Oceanography, p. III-I-7.
7. D. K. Caldwell, D. S. Erdman. 1963. The pilot whale in the West Indies. J. Mammalogy vol. 44, no. 1, pp. 113-115.
8. D. K. Caldwell and F. B. Galley. 1965. Marine mammals from the coast of Georgia to Cape Hatteras. J. Elisha Mitchell Sci. Soc., vol. 81, pp. 24-32.
9. D. K. Caldwell, M. C. Caldwell, W. F. Rathjen, and J. R. Sullivan. 1971. Cetaceans from the Lesser Antillean Island of St. Vincent. U. S. Fish and Wildlife Serv., Fish. Bull., vol. 69, no. 2, pp. 303-312.
10. D. K. Caldwell, W. F. Rathjen, and M. C. Caldwell. 1970. Pilot whales mass stranded at Nevis, West Indies. Quart. J. Fla. Acad. Sci., vol. 33, no. 4, pp. 241-243.
11. K. W. Dammerman. 1926. On *Globicephala* and some Delphinidae from the Indo-Australian Archipelago. Treubia, vol. 5, pp. 340-352.
12. J. L. Davies. 1960. The southern form of the pilot whale. J. Mammalogy, vol. 41, pp. 29-34.
13. W. M. De Smet. 1976. Evidences of whaling in the North Sea and the English Channel during the Middle Ages. Scientific Consultation on Marine Mammals, Bergen, Norway, Advisory Committee on Marine Resource Research, F.A.O., United Nations.
14. R. Duguy. 1968. Note sur *Globicephala macrorhyncha* Gray 1846; un cetace nouveau pour les cotes de France. Mammalia, vol. 32, no. 1, pp. 113-117.
15. F. D. Fraser. 1950. Two skulls of *Globicephala macrorhyncha* from Dakar. Atlantide Report, Scientific Results of the Danish Expedition to the Coasts of Tropical West Africa, 1945-46, vol. 1, pp. 49-60.

16. D. E. Gaskin. 1968. The New Zealand cetacea. New Zealand Marine Dept., Fish. Res. Div. Bull., new series, vol. 1, pp. 1-92.
17. C. A. Gibson-Hill. 1950. A note on the Cetacea stranded on the Cocos-Keeling Islands. Bull. Raffles Museum, vol. 22, pp. 278-279.
18. R. M. Gilmore. 1971. Observations on marine mammals and birds off the coast of southern and central Chile, early winter, 1970. Antarctic J. of the U.S., vol. 6, no. 1.
19. G. Gunter. 1946. Records of the pilot whale or blackfish from the Texas coast. J. Mammalogy, vol. 27, pp. 374-377.
20. G. Gunter. 1954. Mammals of the Gulf of Mexico. In P. S. Galtsoff, Coordinator, Gulf of Mexico: Its Origin, Waters, and Marine Life. U.S. Fish and Wildlife Serv., Fish. Bull., vol. 55, no. 8, pp. 543-551.
21. E. R. Hall, K. R. Kelson. 1959. The mammals of North America, vol. II, New York: Ronald Press, p. 828.
22. P. Hershkovitz. 1966. Catalog of living whales. Smithsonian Inst., U.S. Nat. Museum Bull. 246, pp. 91, 96.
23. A. Jonsgard, I. Christensen. 1968. A preliminary report on the Harobuen cruise in 1968. Norsk Hvalfangs-Tidende, vol. 57, no. 6, pp. 174-175.
24. T. Kasuya. 1971. Consideration of distribution and migration of toothed whales off the Pacific coast of Japan with special reference to whale movements. Sci. Reports of the Whales Res. Inst., Tokyo, no. 23, pp. 37-60.
25. C. Kraus, M. Gahr. 1971. On the presence of *Tursiops truncatus* in schools of *Globicephala melaena* off the Faeroe Islands. In G. Pilleri, Ed., Investigations on Cetacea, vol. III, part 1, pp. 180-182.
26. J. N. Layne. 1965. Observations on marine mammals in Florida waters. Bull. Florida State Mus. Biol. Sci., vol. 9, pp. 131-181.
27. S. Leatherwood, D. K. Caldwell, and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic: A guide to their identification. National Oceanographic and Atmospheric Administration, Technical Report NMFS Circ-396, pp. 91-95.
28. S. Leatherwood, W. Evans, and G. E. Lingle. 1973. The Pacific pilot whale *Globicephala CF. Scammoni*: Evaluation of its effect on high frequency sonar and its utility as an oceanographic monitoring platform. Naval Undersea Center, Technical Note 1164, pp. 6-7, 19-25.
29. S. Leatherwood, W. E. Evans and D. W. Rice. 1972. The whales, dolphins, and porpoises of the eastern North Pacific: A guide to their identification in the water. Naval Undersea Center, Technical Publication 282.
30. G. Marcuzzi, G. Pilleri. 1971. On the Zoogeography of Cetacea. In G. Pilleri, Ed., Investigations on Cetacea, vol. III, part 1, pp. 101-170.

31. J. Maigret, J. Trotignan and R. Duguy. 1976. Observations de cetaces sur les cotes de Mauritanie (1971-1975). Scientific Consultation on Marine Mammals, Bergen, Norway, Advisory Committee on Marine Resource Research, F. A. O., United Nations.
32. S. J. Mathewson. 1935. Blackfish in the Gulf of St. Lawrence. J. Mammalogy, vol. 16, p. 234.
33. M. C. Mercer. 1967. Wintering of pilot whales, *Globicephala melaena*, in Newfoundland inshore waters. J. Fish. Res. Board Can., vol. 24, no. 11, pp. 2481-2484.
34. M. C. Mercer. 1975. Modified Leslie-Delury population models of the long-finned pilot whale (*Globicephala melaena*) and annual production of the short-finned squid (*Illex illecebrosus*) based upon their interaction at Newfoundland. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 1145-1154.
35. E. Mitchell. 1975. Review of biology and fisheries for smaller cetaceans. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 916, 918.
36. E. Mitchell. 1975. Porpoise, dolphin, and small whale fisheries of the world. International Union for Conservation of Nature, Monograph 3, pp. 77-82.
37. J. C. Moore. 1953. Distribution of marine mammals to Florida waters. Amer. Midl. Naturalist, vol. 49, pp. 117-158.
38. M. Nishiwaki. 1967. Distribution and migration of marine mammals in the North Pacific area. Bull. Ocean Res. Inst., vol. 1, pp. 1-64.
39. K. S. Norris, J. H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. Univ. Calif. Pub. Zool., vol. 63, no. 4, pp. 291-402.
40. S. Ohsumi. 1975. Review of Japanese small-type whaling. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 1111-1121.
41. C. E. O'Riordan. 1975. Pilot whales, *Globicephala melaena*, driven ashore in Ireland, 1800-1973. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 1101-1103.
42. R. T. Orr. 1951. Cetacean records from the Pacific coast of North America. Wasmann J. Biol., vol. 9, pp. 147-148.
43. W. H. Osgood. 1901. Natural history of the Queen Charlotte Islands, British Columbia. North American Fauna, vol. 21, p. 25.
44. G.C. Pike, I. B. MacAskie. 1969. Marine mammals of British Columbia. Fish. Res. Board Can., Bull. 171, pp. ix-54.
45. G. Pilleri. 1970. Records of cetaceans off the Italian and Dalmatian coasts. In G. Pilleri, Ed., Investigations on Cetacea, vol. II, pp. 21-24.

46. S. H. Ridgway. 1972. Mammals of the Sea. Charles C. Thomas, Publisher, Springfield, Ill., pp. 126-128.
47. V. B. Scheffer, J. W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Amer. Midl. Naturalist, vol. 39, no. 2, pp. 257-337.
48. D. E. Sergeant. 1961. Whales and dolphins of the Canadian east coast. Fish. Res. Board Can., Circular 7, p. 6
49. D. E. Sergeant. 1968. Environmental surveys - NORWESTLANT 1-3, 1963. International Commission for the Northwest Atlantic Fisheries Special Publication 7, part 1, pp. 241-244, part 2, pp. 284-286.
50. D. E. Sergeant, H. D. Fisher. 1957. The smaller cetacea of eastern Canadian waters. J. Fish. Res. Board Can., vol. 14, no. 1, pp. 83-115.
51. D. E. Sergeant, A. W. Mansfield, and B. Beck. 1970. Inshore records of cetacea for eastern Canada, 1949-68. J. Fish. Res. Board Can., vol. 29, no. 11, pp. 1903-1915.
52. M. M. Sleptsov. 1961. Observations of small cetaceans in Far Eastern seas and northwest Pacific. Trudy Instituta Morfologii Zhivotnykh, vol. 34. Trans. by U.S. Naval Oceanographic Office.
53. A. G. Tomilin. 1967. Mammals of the USSR and adjacent countries. Cetacea, vol. 9, pp. 589-590.
54. D. Vallon, C. Guigo and R. Duguy. 1976. Le Globicephale noir, *Globicephala melaena* (Traill, 1809) en Mediterranee occidentale. Scientific Consultation on Marine Mammals, Bergen, Norway, Advisory Committee on Marine Resource Research, F. A. O., United Nations.
55. P. B. H. Van Bree, P. B. Best and G. J. B. Ross. 1976. Occurrence of the two species of pilot whales (genus *Globicephala*) on the coast of South Africa. Scientific Consultation of Marine Mammals, Bergen, Norway, Advisory Committee on Marine Resource Research, F. A. O., United Nations.

KILLER WHALE

DESCRIPTION

Striking body colors and a large dorsal fin make the killer whale easy to identify. They are black with a white underside, a large white oval patch behind and above the eye, and a gray "saddle" behind the dorsal fin. In males the dorsal fin is erect and reaches a height of 6 feet (1.8 m) or more; in females and juveniles it is slightly falcate and approximately 3 feet (0.9 m) high. A photograph of a typical animal is shown in figure 7.

Killer whales are the largest members of the dolphin family. Males reach a maximum length of approximately 30 feet (9.1 m) and females of approximately 24 feet (7.0 m). Although groups of up to 150 individuals have been observed, killer whales usually travel in groups of 25 to 30 individuals or fewer. Their main diet is fish, but in some locations and seasons they also eat turtles, seabirds, and other marine mammals.



Figure 7. Killer whale.

DISTRIBUTION

Killer whales have been observed in all major oceans and seas of the world. They appear to be most abundant within 500 miles (800 km) of major continents and in colder coastal waters. Detailed information on their distribution, however, is difficult to obtain, and the status of populations on a worldwide basis is not known (42).^{*} Most of the reliable information is for coastal waters near population centers. Information for open ocean areas is sparse.

The seasonal movements of killer whales are not well known. In some areas they are migratory, while in others they are apparently present the year around. Their movements seem to be related primarily to movements of the food supply (7, 15). Killer whales are observed in the Arctic and Antarctic up to the edge of the seasonal ice pack.

Killer whales are known to strand themselves, and in many areas strandings furnish the only documented evidence of their occurrence. While strandings provide useful information on distribution, they should not be used to draw conclusions regarding seasonal occurrence or migration habits. Factors other than abundance, such as weather and parasitic infestation, may affect the probability of strandings. Killer whales have also been the object of local fisheries, but catch data must similarly be used with caution in estimating abundance.

The seasonal abundance of killer whales is well known only in the following areas: southeastern Alaska, the Aleutian Islands, and the Pribilof Islands (50, 53, 70); Queen Charlotte Sound, Georgia Strait, and Johnson Strait (21); Japan (15); Iceland and Greenland (57, 65, 67); Great Britain and Ireland (30, 70); and the Antarctic (26, 77).

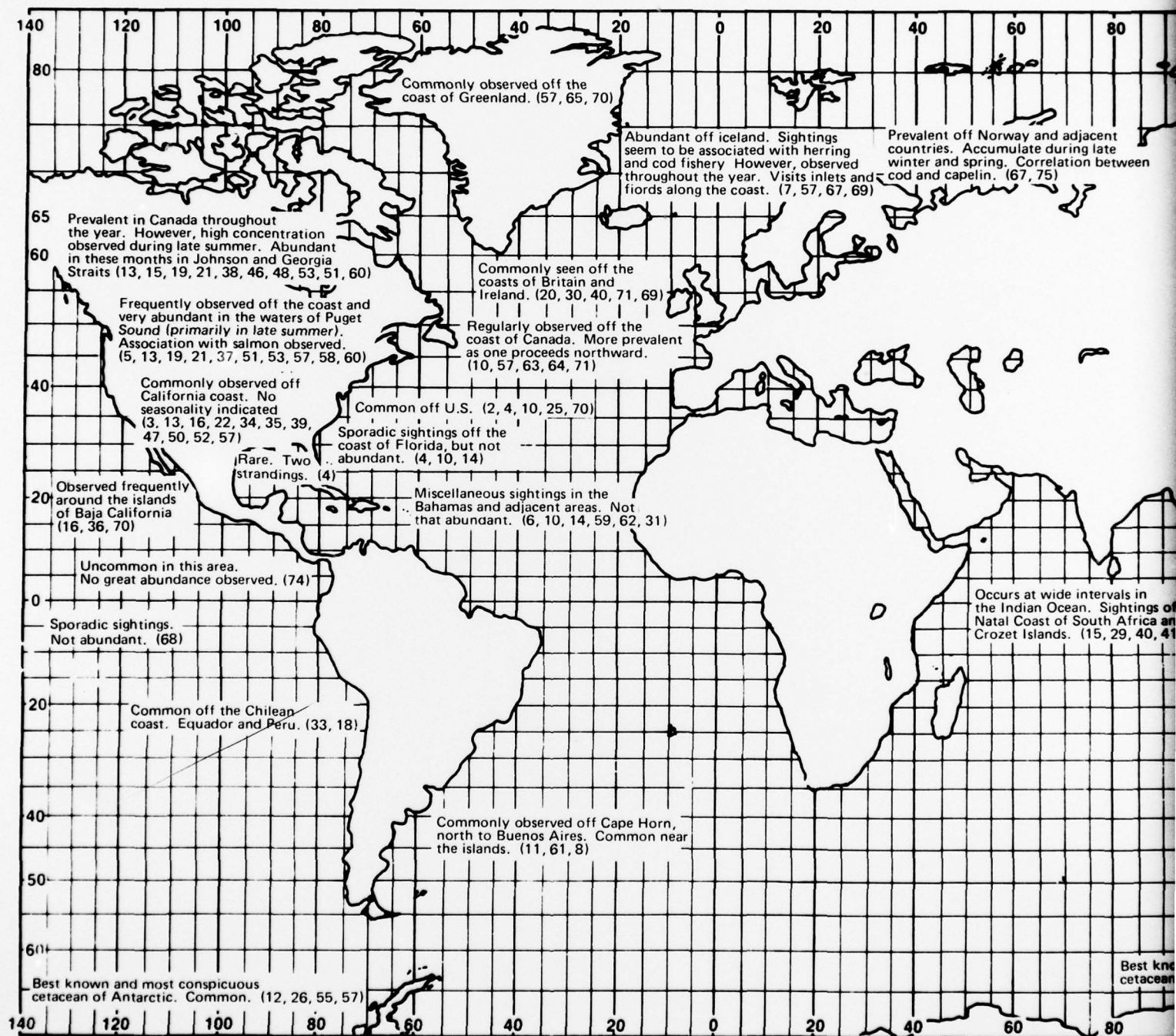
The available data on the worldwide distribution of killer whales are presented in the following paragraphs. Figure 8 is a map of the world summarizing the available distribution data, and figure 9 is a similar map indicating the probability of encountering killer whales in the oceans of the world. As with pilot whales, the present state of knowledge does not permit us to provide reliable distribution information, on a seasonal basis, for all areas of the world. For the most part we can only indicate general trends in distribution and abundance and provide tentative predictions of the probability of encounter.

North Atlantic

There is considerable information available on killer whale distribution and movements in the polar and temperate North Atlantic.

Killer whales remain in the cold waters of the Arctic until driven out by ice, which in winter reaches the subarctic waters off eastern Baffin Island and Lancaster Sound in the eastern Canadian waters (63). Sightings have been reported from the Strait of Belle Isle, thence southward, including the Bay of Fundy, Newfoundland, and off the eastern coast of Canada and the United States. Sightings are more numerous off the northern U.S. seaboard than off the southern seaboard (10).

^{*} Numbers in parentheses identify publications on killer whales listed in the bibliography at the end of the report.



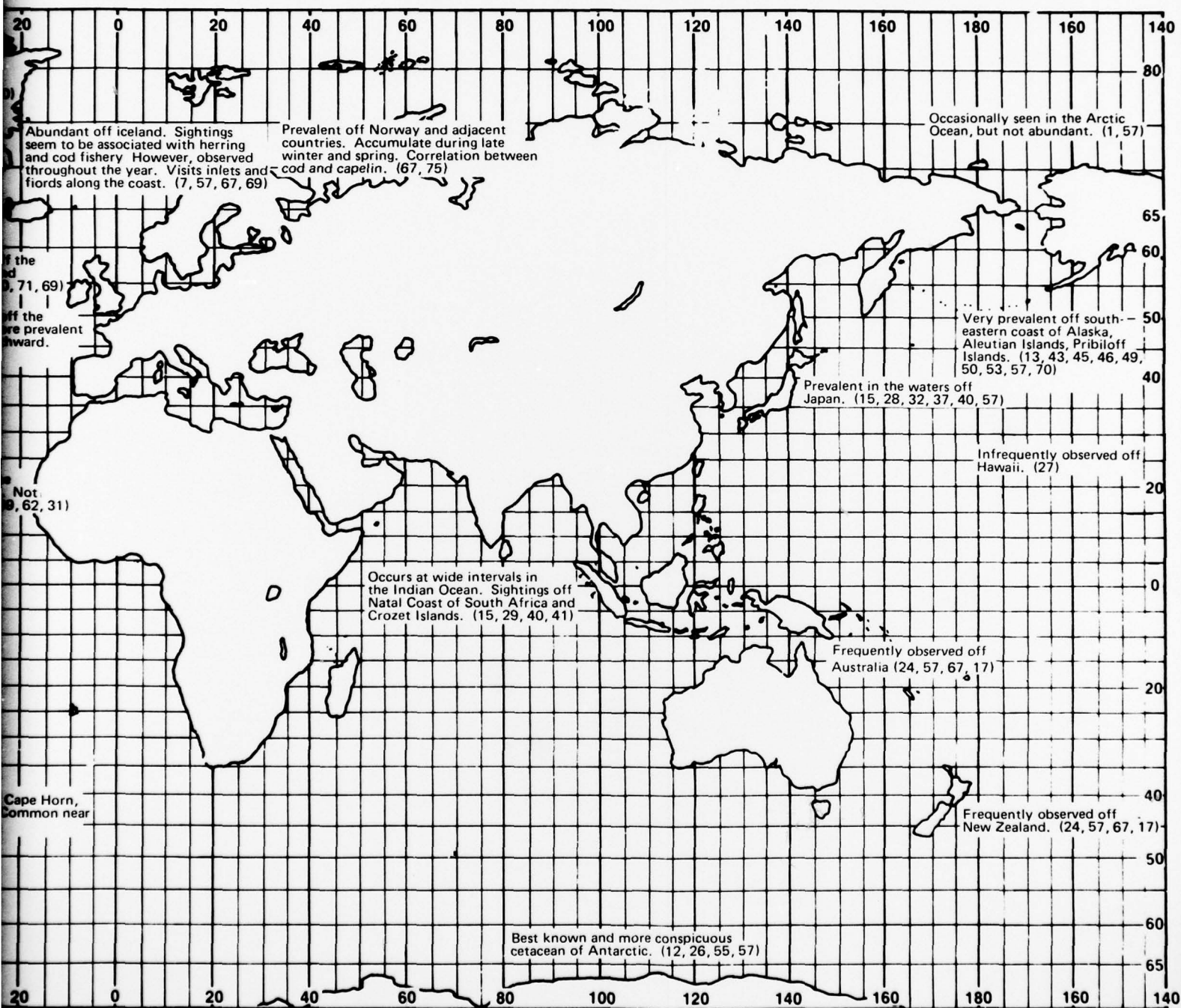


Figure 8. Summary of published information on the worldwide distribution of the killer whale.

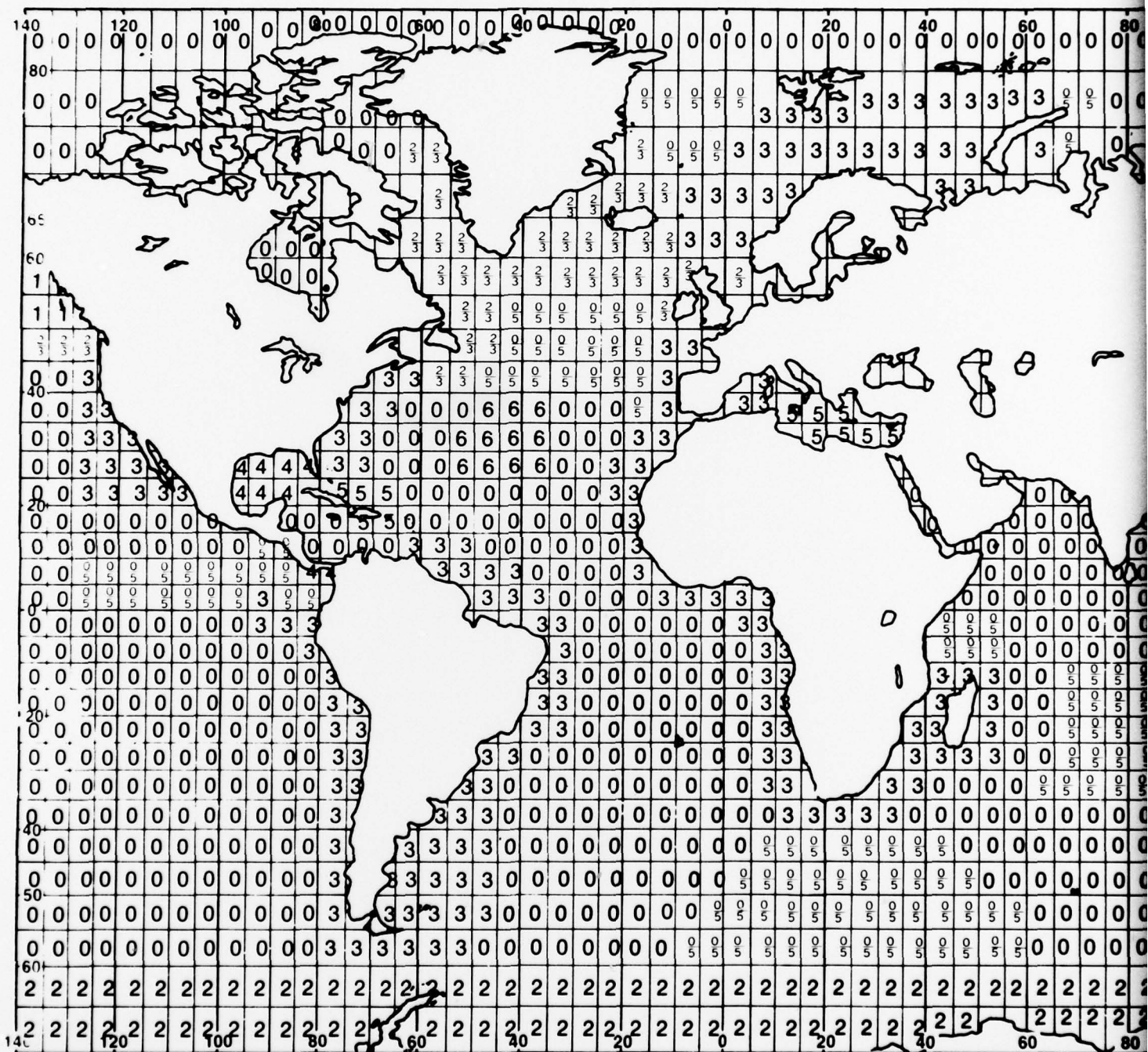


Figure 9. I
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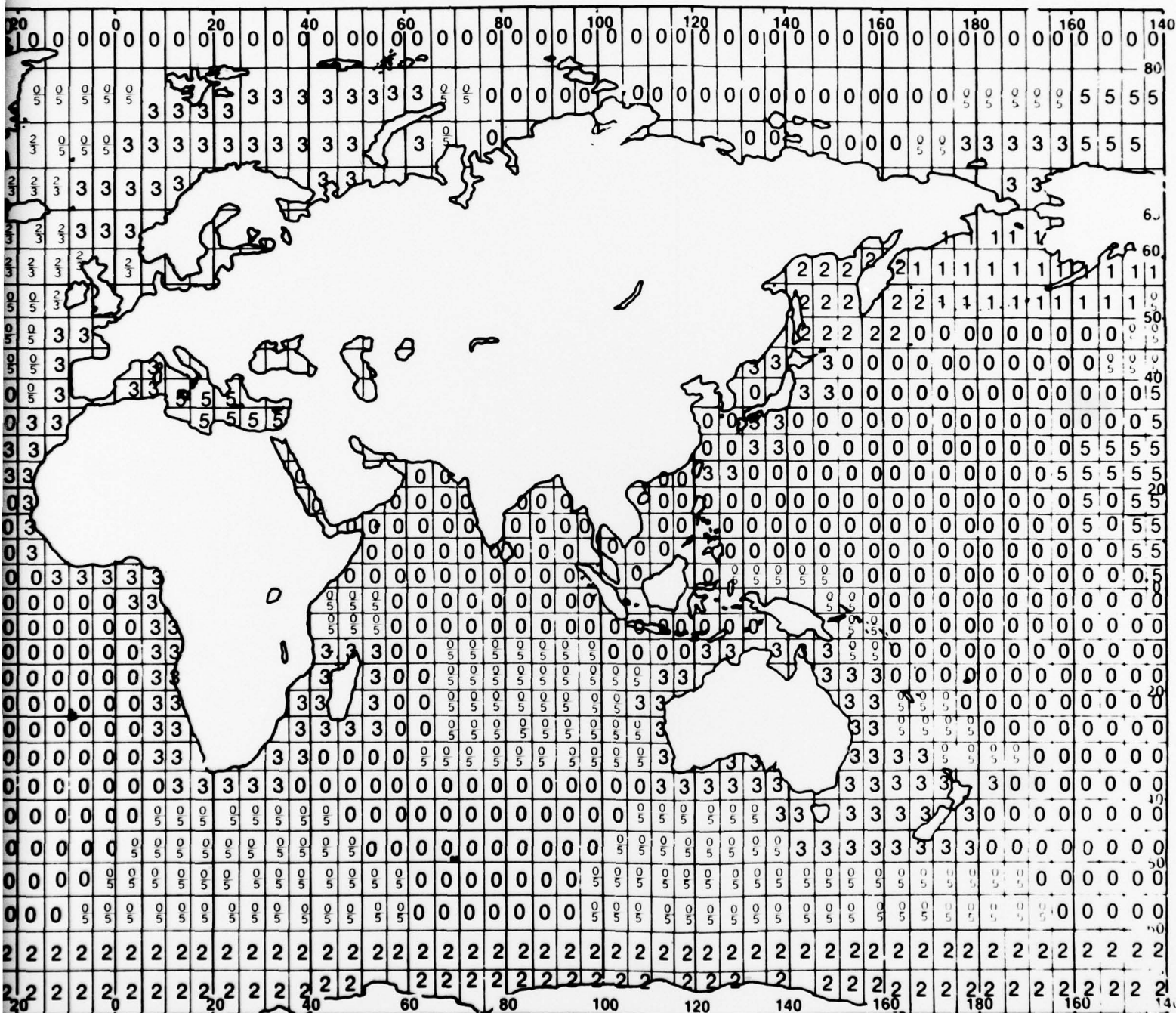


Figure 9. Likelihood of occurrence of the killer whale in the world's oceans.

- Key:
- 0 = no published information, status unknown;
 - 1 = published record indicates abundance the year around;
 - 2 = published record indicates presence the year around;
 - 3 = published record indicates seasonal presence;
 - 4 = presence reported but natural occurrence questionable;
 - 5 = presence not reported but predicted;
 - 6 = presence not reported and not predicted.

Killer whales are frequently noted off Greenland and Iceland throughout the year. In summer they occur in the Barents and White seas and off Novaya Zemlya and Spitsbergen (57).

Many stranding records and sighting reports document their occurrence off Great Britain and Ireland (30). They are commonly observed off the coasts of Norway, France, Holland, Belgium, and Denmark. Here, as on the western shores of the Atlantic, sightings become more sporadic as one proceeds southward from approximately 30°N to 5°S latitude.

We have no data for the Sargasso Sea, but from knowledge of the general conditions in this area and of the other cetaceans found here, we assume that killer whales are not present.

Mediterranean

In the Mediterranean, killer whales occur near the French coast. Observations have been reported from Morocco, Sicily, Malta, Corsica, and Sardinia (57). There is no information on strandings in this area. There are no records from the eastern Mediterranean, or from the Black or Adriatic seas.

Central Atlantic

Killer whales occur throughout the West Indies and Bahamas, although sightings are sporadic (14). They occur in the Gulf of Mexico but are usually considered uncommon in this area (4). Catch information is available from St. Vincent in the Lesser Antilles, where three were taken in 1968 (59). There is no information available for the eastern Caribbean.

Some strandings along the Florida coast have been documented, and sightings have been recorded from time to time. However, most observers feel that killer whales are not abundant off Florida (14). Too few sightings are available to indicate seasonal presence or absence in any tropical Atlantic area.

Eastern North Pacific

More information regarding the presence of killer whales is available for the eastern North Pacific than for any other geographical area. They are abundant off the Aleutian Islands, Pribilof Islands, and southeastern Alaska. The high productivity of these waters probably results in abundance throughout the year (53). They have been reported as far as 20 or 30 km up Alaska's Kvichak River in east Bristol Bay (43).

Killer whales are found throughout the year off British Columbia (60) and in the channels of the intracoastal waterways. Their greatest reported abundance is in late summer, when they appear to concentrate in Queen Charlotte Sound, the Strait of Georgia, and Johnson Strait. Most observers believe that their seasonal abundance in these waters is due to the presence of salmon.

In the marine waters of the State of Washington, killer whales are prevalent during all seasons. They are frequently seen in the Strait of Juan de Fuca and off the Olympic seacoast and are perhaps less common farther south on the coast and in the Columbia estuary. In Puget Sound they are somewhat more common in the north, congregating especially in summer at the mouth of the Fraser River, in Washington Sound, and off Camano Island during the salmon and herring runs. They are apparently more abundant in spring and fall near Tacoma and in south Puget Sound (19).

Killer whales have been sighted off the coast of Washington, Oregon, and California (13). No seasonal patterns are apparent for any of these areas (35). They frequently visit the offshore islands of Baja California, areas rich in game fish and supportive of large sea lion and elephant seal rookeries. Sightings have been reported as far south as Cabo San Lucas. They occur at wide intervals in the Gulf of California, and appear to be more prevalent in the southern part.

Western North Pacific

Killer whales are abundant off the coast of Japan and are frequent visitors to the Sea of Japan, Sea of Okhotsk, and Bering and Chukchi seas (28). Although most sightings are made between 35°N and 45°N in the months from April through November, no clear seasonal patterns are indicated.

Killer whales are taken commercially in all regions off Japan, but the greatest numbers are taken off Hokkaido and Sanriku (32).

Central Pacific

Data on the presence of killer whales in the central Pacific are scarce. They have been reported off Hawaii, but do not appear abundant in these waters. In 1950 a stranding was reported from Kalae Point, Oahu (27). Data on their occurrence east and south of Hawaii are more numerous (78).

South Atlantic

Information on the presence of killer whales in the South Atlantic is also scarce. They are prevalent from Cape Horn north to Buenos Aires (61), and their presence can be predicted off the northeast coast of South America. There are numerous records of killer whales off the Falkland Islands.

Killer whales have been observed off Capetown (79). As one follows the coastline of Africa northward, sightings are less prevalent. They probably occur off the northwest coast of Africa but not in great abundance.

South Pacific

Killer whales have been noted in most parts of the South Pacific Ocean. Observations have been made of pods numbering up to 200 animals among the South Shetland Islands and near Clarence and Elephant Islands and the South Orkneys (8). They are

commonly observed in the Bay of Plenty, particularly near the offshore islands, such as Motiti, White, Major Islands, and the Mercury Islands. Reports from fishermen in the area indicate that at least part of the population is resident throughout the year.

Killer whales have been recorded as far south as McMurdo Sound, and are noted to be the commonest cetaceans of the Ross Sea (17). They are commonly seen off Australia and New Zealand (24). They are abundant in the Chilean area (33), and appear to be present there the year around. They are often seen off Ecuador and Peru and sporadically as far north as the Galapagos Islands. Their mid-ocean distribution is not known.

Indian Ocean

Records of killer whales in the Indian Ocean are sparse. There are catch reports from the Natal coast of South Africa (40), and there are sightings off the Crozet Islands (41). General distribution and seasonal patterns, however, are not known.

KILLER WHALE: BIBLIOGRAPHY

1. A. V. Yablokov, V. M. Belkovich. 1968. Cetaceans of the Arctic: Prospect of their proper utilization and conservation. Problems of the North, no. 11.
2. D. K. Caldwell, F. B. Golley. 1965. Marine Mammals from the coast of Georgia to Cape Hatteras. J. Elisha Mitchell Sci. Soc., vol. 81, no. 1, pp. 24-32.
3. Anonymous. 1976. Marine mammal and sea bird survey of the Southern California Bight area. Draft final report. Regents of the Univ. of California, Santa Cruz.
4. D. K. Caldwell *et al.* 1956. Notes on a killer whale (*Orcinus orca*) from the north-eastern Gulf of Mexico. Quart. J. Fla. Acad. Sci., vol. 19, no. 4, pp. 189-196.
5. C. G. Clifford. 1948. Killer whales. Victoria Naturalist, vol. 5.
6. D. S. Erdman. 1970. Marine mammals from Puerto Rico to Antigua. J. Mammalogy, vol. 51, no. 3, pp. 636-639.
7. A. Jønsdahl. 1952. Om bottlenosen og spekkhoggeren. Særtrykk av Fauna, no. 1, pp. 1-17.
8. D. E. Gaskin. 1968. The New Zealand Cetacea. New Zealand Marine Dept., Fish. Res. Div. Bull., new series, vol. 1.
9. D. J. Schmidly, B. A. Melchor. 1974. Dolphins of Texas. Texas Agricultural Exp. Sta., Dept. of Wildlife and Fish Sciences, Texas A & M Univ.
10. R. H. Backus. 1961. Stranded killer whale in the Bahamas. J. Mammalogy, vol. 42, pp. 418-419.
11. J. E. Hamilton. 1952. Cetacea of the Falkland Islands. Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo, vol. 4, no. 66, pp. 1-6.
12. H. P. Castello *et al.* 1974. First Antarctic record of a killer whale stranding. Sci. Reports of the Whales Res. Inst., Tokyo, no. 26, pp. 255-258.
13. J. McDermott. 1973. Killer whales. Animal Kingdom, vol. 76, no. 3, pp. 2-8.
14. J. C. Moore. 1953. Distribution of marine mammals to Florida waters. Amer. Midl. Naturalist, vol. 49, pp. 138-140.
15. M. Nishiwaki, C. Handa. 1958. Killer whales caught in the coastal waters off Japan for recent 10 years. Sci. Reports of the Whales Res. Inst., Tokyo, no. 13, pp. 85-96.
16. K. S. Norris, J. H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. Univ. Calif. Pub. Zool., vol. 63, no. 4, pp. 330-334.

17. W. R. B. Oliver. 1922. A review of the Cetacea of the New Zealand seas. Proc. Zool. Soc. London.
18. C. C. Olrog. 1950. Notas sobre mamiferos y aves del archipelago de Cabo de Hornos. Act. Zool. Lilloana, Tucuman, Argentina, vol. 9.
19. V. B. Scheffer, J. W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Amer. Midl. Naturalist, vol. 39, no. 2, pp. 274-287.
20. S. F. Harmer. 1927. Report of Cetacea stranded on the British coasts from 1913-1926. Brit. Mus. Nat. Hist., Report 10.
21. M. A. Bigg *et al.* 1976. Abundance and movements of killer whales off eastern and southern Vancouver Island with comments on management. Arctic Biological Station, Sainte Anne de Bellevue, Quebec, Preliminary report, pp. 1-20.
22. B. Burrage. 1964. An observation regarding gray whales and killer whales. Trans. Kans. Acad. Sci., vol. 67, no. 3, pp. 550-551.
23. J. Pearson. 1935. The whales and dolphins of Tasmania. Part 1, External Characters and habits. Papers and Proceedings of the Royal Soc. of Tasmania, pp. 163-192.
24. T. Iredale, T. E. Troughton. 1969. A checklist of the mammals of Australia. Mem. Aust. Mus. Sydney, vol. 6, pp. 63-68.
25. F. A. Ulmer. 1941. Notes on a killer whale (*Grampus orca*) from the coast of New Jersey. Notulae Naturae, no. 83.
26. B. A. Zenkovich. 1962. Sea mammals as observed by the round the world expedition of the Academy of Sciences of the U. S. S. R. in 1957/58. Norsk Hvalfangst-Tidende, vol. 51, pp. 198-210.
27. L. P. Richards. 1952. Cuvier's beaked whale from Hawaii. J. Mammalogy, vol. 33, p. 255.
28. T. Kasuya. 1971. Consideration of distribution and migration of toothed whales off the Pacific coast of Japan based on aerial sighting records. Sci. Reports of the Whales Res. Inst., Tokyo, no. 23, pp. 37-60.
29. E. Mitchell. 1975. Review of biology and fisheries for smaller cetaceans. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 914-916.
30. S. G. Brown. 1975. Relation between stranding mortality and population abundance of smaller Cetacea in the northeast Atlantic Ocean. J. Fish. Res. Board Can., vol. 32, no. 7.

31. D. K. Caldwell, M. C. Caldwell. 1975. Dolphin and small whale fisheries of the Caribbean and West Indies: Occurrence, history, and catch statistics, with special reference to the Lesser Antillean Island of St. Vincent. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 1105-1110.
32. S. Ohsumi. 1975. Review of Japanese small-type whaling. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 1111-1121.
33. A. Aguayo. 1975. Progress report on small cetacean research in Chile. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 1123-1143.
34. D. H. Brown, K. S. Norris. 1956. Observations of captive and wild cetaceans. J. Mammalogy, vol. 37, no. 3, pp. 325-326.
35. R. M. Gilmore. 1976. Killer whales in the San Diego area, Del Mar to the Coronado Islands. Newsletter of the American Cetacean Society, San Diego, pp. 4-5.
36. R. G. Van Gelder. 1960. Results of the Puritan-America Museum of Natural History expedition to western Mexico. Am. Mus. Nat. Hist., Bull. 1992, p. 5.
37. M. Nishiwaki. 1967. Distribution and migration of marine mammals in the North Pacific area. Bull. Ocean Res. Inst., Tokyo, no. 1, p. 40.
38. G. C. Pike, I. B. MacAskie. 1969. Marine mammals of British Columbia. Fish. Res. Board Can., Bull. 171, pp. 19-23.
39. A. Baldrige. 1972. Killer whales attack and eat a gray whale. J. Mammalogy, vol. 53, no. 4, pp. 898-900.
40. E. Mitchell. 1975. Porpoise, dolphin, and small whale fisheries of the world. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland, Monograph 3.
41. J. F. Voisin. 1972. Notes on the behavior of the killer whale, *Orcinus orca*. Norw. J. Zool., vol. 20, pp. 93-96.
42. Anonymous. 1975. Killer whale, *Orcinus orca*. J. Fish. Res. Board Can., vol. 32, no. 7, pp. 914-916.
43. J. F. Fish, J. S. Vania. 1971. Killer whale sounds repel white whales. Fishery Bull., vol. 69, no. 3, pp. 531-535.
44. P. Hershkovitz. 1966. Catalog of living whales. Smithsonian Inst., U. S. Nat. Museum Bull. 246, pp. 81-86.
45. J. Branson. 1971. Killer whales pursue sea lions in Bering Sea drama. Commercial Fisheries Review, March, pp. 39-40.

46. C. Seammon. 1968. Marine mammals of the north-western coast of North America. New York: Dover Publications, Inc.
47. G. V. Morejohn. 1965. A killer whale - gray whale encounter. *J. Mammalogy*, vol. 49, no. 2, pp. 327-328.
48. D. Hancock. 1965. Killer whales kill and eat a minke whale. *J. Mammalogy*, vol. 46, no. 2, pp. 341-342.
49. V. B. Scheffer. 1969. Marks on the skin of a killer whale. *J. Mammalogy*, vol. 50, part 1, pp. 151-152.
50. D. W. Rice. 1968. Stomach contents and feeding behavior of killer whales in the eastern North Pacific. *Norsk Hvalfangst-Tidende*, no. 2, pp. 35-38.
51. M. A. Bigg, A. A. Wolman. 1975. Live-capture killer whale fishery, British Columbia and Washington, 1962-73. *J. Fish. Res. Board Can.*, vol. 32, no. 7, pp. 1213-1221.
52. D. K. Caldwell, D. H. Brown. 1964. Tooth wear as a correlate of described feeding behavior by the killer whale, with notes on a captive specimen. *Bull. So. Calif. Acad. Sci.*, vol. 63, part 5, pp. 128-140.
53. S. Leatherwood *et al.* 1972. The whales, dolphins, and porpoises of the eastern North Pacific, a guide to their identification in the water. Naval Undersea Center, Technical Publication 282.
54. E. Banks. 1931. Mammals of Borneo. *J. Malayan Branch Royal Asiatic Society*, vol. 9, part 2, pp. 13-16.
55. R. T. Orr. 1972. Marine mammals of California. Univ. of Calif., Berkeley.
56. G. Gunter. 1972. Mammals of the Gulf of Mexico. Inst. of Marine Science, Univ. of Texas.
57. A. G. Tomilin. 1957. Mammals of the U. S. S. R. and adjacent countries. Moskva: Izdatel'stvo Akademii Nauk SSSR, vol. 9, pp. 605-626.
58. V. B. Scheffer. 1967. The killer whale. *Pacific Search*, vol. 1, no. 7, pp. 3-4.
59. D. K. Caldwell, M. C. Caldwell. 1969. Addition of the leatherback turtle to the known prey of the killer whale, *Orcinus orca*. *J. Mammalogy*, vol. 50, no. 3, p. 636.
60. M. A. Newman, P. L. McGeer. 1966. The capture and care of a killer whale, *Orcinus orca*, in British Columbia. *Zoologica*, vol. 51, no. 2, pp. 59-78.
61. A. Ximenez *et al.* 1972. Lista sistematica de las mamiferos del Uruguay. *Am. Mus. Nat. Hist.*, Montevideo, series 2a, vol. 7, no. 5, pp. 1-49.

62. J. N. Layse. 1965. Observations on marine mammals in Florida waters. *Bull. Fla. State Mus., Biol. Sciences*, vol. 9, no. 4, pp. 131–181.
63. D. E. Sergeant. 1961. Whales and dolphins of the Canadian east coast. *Fish. Res. Board Can., Circular* 7.
64. D. E. Sergeant *et al.* 1970. Inshore records of Cetacea for eastern Canada, 1949–68. *J. Fish. Res. Board Can.*, vol. 29, no. 11, p. 1910.
65. F. O. Kapel. 1975. Preliminary notes on the occurrence and exploitation of smaller Cetacea in Greenland. *J. Fish. Res. Board Can.*, vol. 32, no. 7.
66. W. H. Flower. 1885. List of the specimens of Cetacea in the Zoological Department of the British Museum. London: British Museum.
67. A. Jonsgard, P. B. Lyshoel. 1970. A contribution to the knowledge of the biology of the killer whale, *Orcinus orca*. *Nytt Magasin for Zoologi*, vol. 18, no. 1, pp. 41–48.
68. R. Leveque. 1963. *Orcinus orca*, orque. *Mammalia*, vol. 27, no. 4, p. 609.
69. C. E. O'Riordan. 1972. Provisional list of Cetacea and turtles. *Proc. Royal Irish Acad.*, vol. 72, sect. B, no. 15, p. 263.
70. E. R. Hall, K. R. Kelson. 1959. *Mammals of North America*, vol. 2, New York: Ronald Press, pp. 806–832.
71. F. C. Fraser. 1934, 1946, 1953. Report on Cetacea stranded on the British coasts, no. 11, no. 12, no. 13. London: Brit. Mus. Nat. Hist.
72. J. A. Harder, C. L. Johannessen. 1960. Sustained swimming speeds of dolphins. *Science*, vol. 32, no. 3439, pp. 1550–1551.
73. D. H. Brown, K. S. Norris. 1956. Observations of captive and wild cetaceans. *J. Mammalogy*, vol. 37, no. 3, pp. 325–326.
74. B. Lacepede. 1804. *Histoire naturelle des cetacees*, p. 298.
75. D. F. Eschricht. 1866. On the species of the genus *Orca* inhabiting the northern seas. In W. H. Flower, Ed., *Recent Memoirs on the Cetacea*. Royal Society, London, pp. 151–188.
76. R. Chandler *et al.* 1977. Who is that killer whale? *Pacific Search*, vol. 11, no. 7, pp. 25–35.
77. S. G. Brown *et al.* 1974. Antarctic mammals. Folio 18, Antarctic Map Folio Series, American Geographical Soc., pp. 13–19, plates.

78. J. S. Leatherwood *et al.* 1978. Distribution and index of killer whales in the eastern tropical pacific. In press.
79. W. C. Cummings. 1971. Unpublished report of collisions of marine mammals with boats. Naval Undersea Center.